Massachusetts Institute of Technology
Bulletin

Report of the President and the Chancellor Issue
1974-1975
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October 3, 1975
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ALUMNI ASSOCIATION
M.I.T. is alive and well, though not without its problems. A glance through our past annual Reports reveals that we have seen each recent year as a new and perhaps increasing challenge -- a mixture of constraints and opportunities, some self-generated but most a reflection of conditions in the country itself. One wonders in passing if each year is increasingly a challenge or whether, as we muse in these Reports, we should not reach for a better word to describe the rapidly changing state of the Institute and the society in which it functions.

These are, to be sure, troubled times, and the conjunction of recession, inflation, the diminution of trust, and a general sense of social malaise are causing strains in most institutions and organizations, M.I.T. included. But there have been challenging times before in the history of the Institute -- moments when even its very survival seemed to be in doubt -- such as in the aftermath of the Civil War and in the severe depression of the 1870s. The Institute has lived through many times when the society seemed confused and drifting; it has emerged from each of these periods basically stronger and better prepared to carry on its work. Frequently such times have been moments of great opportunity as well as anxiety for they usually involved a rediscovery of the essence of the Institute.

We should take heart from the outcome of those earlier periods as we strive to maintain and add to M.I.T.'s special strengths, and to encourage the development of those activities and attitudes that will make M.I.T. a vital and important place in the future. Such efforts require not the reactive stance which is implied by the word "challenge" but a positive vision of the leadership role that an institution like M.I.T. should play in the education of bright and concerned young men and women, in the exploration of new realms of theory and practice, and in the cooperative evolution of an increasingly responsive and humane society. At a time when the newspapers carry stories on cities on the verge of bankruptcy, universities in serious financial straits, many people in fear of job loss, and belt-tightening in virtually every domain, talk of visions of a rosy future may seem quixotic in the extreme. But vision is precisely what is needed, for only a well-articulated view of what the future could be gives focus and heart to the efforts to get from here to there.

The components of our vision for M.I.T. have been discussed in many contexts -- continued intellectual excellence, outstanding departments and programs, responsiveness to major technical and socio-technical needs of our world-wide society, the encouraging of warmth and responsiveness as well as analytic precision in our students, and the achievement of fairness, equity, and respect among all of us who work and study here. The affirmation of that vision, well-grounded in the current life of the Institute and played out in the daily activities of hundreds of people -- faculty, students, and staff alike, is the fundamental theme of this year's Report.

In recent annual Reports we have examined M.I.T.'s teaching and research activities in relation to the technical, social, and economic milieu and stressed especially our belief in the potential for learning and growth inherent in the American society. We also discussed the need to develop and wisely use new technology to help satisfy many growing needs such as food, raw materials, energy, environmental protection, housing, and health care. We described M.I.T.'s strong efforts to understand and to help moderate the nation's
problems both through its traditional roles in teaching and research, and through substantial efforts to align M.I.T.'s own processes and community relationships with current societal objectives.

At the same time a less positive theme has run through our recent Reports, the ever more painful effort to keep the Institute's budget from running away and the many new tasks and constraints -- affirmative action, control of information to insure privacy, occupational safety, regulations affecting the laboratory use of animals, controls on human experimentation, etc. -- imposed in addition to older, more familiar ones. Together these trends have placed increasingly heavy pressures and workloads on everyone in the Institute -- those men and women who provide vital support services, secretaries, administrators, faculty, researchers, students, and especially department chairmen -- adding greatly to the strain that would in any event be inherent in a rapidly evolving academic program. In the Reports of our colleagues, the Deans, Vice Presidents, Department Heads, and Laboratory Directors, there is much reference to the stresses that come from trying to do more with less. The constraints are real; in some cases externally imposed, in other cases self-imposed. But mingled in these same reports are imaginative ways to actually achieve more with less, accounts of rigorous examination of priorities and newly emerging areas of growth and development.

The resulting mood on the campus is hard to define. In fact, the mood varies greatly from time to time, area to area, and individual to individual. It can perhaps be described as a mixture of enthusiasm and tautness. The overall thrust remains forward looking, creative, and hopeful. But the tensions brought about by fiscal pressures, after years of social pressures and turmoil, are clearly growing, introducing concerns which drain energies from creative activities. These drains are not unique to M.I.T. In fact, though pressures may be as great at the Institute as elsewhere, the consequent unhappiness appears to be less so -- perhaps due to the purposefulness of the M.I.T. programs.

Next year, as we continue the essential efforts to control the financial picture, we intend to give special attention to ways of moderating the resulting tensions, particularly those created by the increasing administrative demands upon individuals' time. The Institute is learning to live in a new period in which rapid growth cannot be maintained, but in which the same kind of vitality and change that come easily with apparently unlimited growth are especially needed. Now they must come more from inner resources, intellectual and financial -- and they do, but not without considerable discomfort.

M.I.T.'s programs continue to appeal to students. Undergraduate and graduate student enrollments have risen this year, as have applications for next year in both categories. There were approximately 145 more freshmen in the Class of 1978 (a total of 1,040) than in the previous year when the class was unusually small because of dormitory space limitations. One hundred and ten more graduate students were also in attendance in spite of the shortage of funds for fellowships and teaching and research assistantships.

In last year's Report we reviewed the evolution over the past 15 years of M.I.T.'s undergraduate education. This year we had hoped to do a similar review of what had happened to graduate education at M.I.T. during the same period. However, we soon became aware that neither the data nor the conceptualizations to do a thorough job were readily available. Since the last formal review of graduate education was conducted nearly ten years ago -- when Federal support for graduate education was perhaps near its peak -- there has been much change in terms of financial support, research interests, career opportunities (academic institutions, industry, and government), composition of the graduate student body (fellows, teaching assistants, research assistants, minorities, women, non-U.S. citizens), to name just some of the dimensions that need to be examined actively.
Since the rapid expansion of the Graduate School paralleled the expansion of research both on the campus and in the country more generally, there is a need for a deeper understanding of how this expansion reflects the state of the several fields and what influence basic and mission-oriented research have had in each instance. During this same period there has come about a fairly drastic increase in the postdoctoral population; hence the structure of the basic M.I.T. "learning family" -- faculty, undergraduate and graduate students, postdoctoral fellows and other research associates in addition to technical support of personnel -- has changed quite considerably.

Finally, there is a need to understand better the changing cost of graduate education as well as the changing social environment of graduate students. We feel sufficiently the need to gain a deeper understanding of this entire complex of issues that we propose -- at this propitious moment when Professor Kenneth R. Wadleigh has just become Dean of the Graduate School -- to have a group of faculty and administration study this area during the current academic year. We hope to report our findings next year at this time.

Some of the trends in undergraduate education, as discussed in last year's Report, continue. The great interest in health careers is sustained as indicated by the fact that 186 men and women applied to medical schools from M.I.T. this past year, 115 were seniors and the rest alumni and juniors. This emphasis has placed a heavy teaching load on the Department of Biology and created an increased, but not yet troublesome, demand for some chemistry subjects. At the same time, there is a substantial decline in law as a career among M.I.T. students, no doubt reflecting the fact that job opportunities for recent law school graduates are less available than they were a few years ago.

Perhaps the most important trend to emerge in recent years is the increasing fraction of the undergraduate student body choosing one of the engineering options, reversing a decline that had persisted for a number of prior years. Approximately 45 percent of this year's sophomores who designated a major are enrolled in the School of Engineering. This brings the total undergraduate enrollment in engineering to 44 percent for the Classes of '76, '77, and '78, up from 36 percent in 1971-72. There is no obvious reason, perhaps not even a single reason for this welcome development. We know that the nationwide decline in engineering enrollments has stopped, no doubt due to the relatively better employment prospects that engineering enjoys at this moment compared to many other careers, but the resurgence of student interest in the engineering profession appears to be more pronounced at M.I.T. than elsewhere.

We would like to believe that renewed student interest in engineering as a career is a reflection of the School's own efforts at renewal and its redefinition to furthering the evolution of the engineering profession in response to broadened professional scope, including the engineering sciences and technologies, the process of engineering (i.e., the conception and development of reliable and economical technical solutions), and the process of planning responsible uses of technology.

The growing conflict between the many new opportunities for teaching and research that were developing and the mounting financial pressures and resulting budget reductions in the departments caused the Dean of Engineering, Alfred A. H. Keil, to seek and obtain the participation of the School's faculty and staff in a comprehensive process of self-appraisal. The objective of this effort was to identify alternative courses of action which would assure the quality and meaningfulness -- the greatness -- as well as the financial viability of the School. A number of panels, each with assigned responsibilities, and a coordinating committee consisting of the chairmen of these panels were established. In all, more than 100 members of the School's faculty and staff were involved in the process. The panels have now completed their work and have submitted their reports. These reports, which contain
upwards of 50 recommendations, are being synthesized into a final report to be distributed to the faculty early in the 1975-76 academic year. The recommendations in the report deal with issues such as the academic and administrative structure of the School, the School's planning and budgeting process, the academic calendar, approaches to new educational and research programs for the School, and financial and student administrative processes.

One recommendation which may well have importance for other parts of the Institute was the introduction of a program planning and budgeting process which would permit the integration of individual program elements in terms of priority, intensity, and cost. In order to deal responsibly with both the constraints of financial pressures and new opportunities for advancing the School's teaching and research programs, the School of Engineering has actually begun the implementation of this recommendation with the preparation of the budget for fiscal year 1976. Preliminary discussions of the other recommendations have occurred already at Engineering Council and further discussions with the Council and the School's faculty are anticipated for the fall.

A major turning point appears to have been reached in the long effort to create a humanities and arts program for M.I.T. that simultaneously reflects the humanistic goals of a liberal education -- the values, historical insights, and cognitive styles that it seeks to make one sensitive to -- and still links sufficiently to the modern world of engineering and science. Several developments contribute to this sense of movement. The new Institute Requirement in Humanities, Arts, and Social Sciences, approved by the faculty in spring, 1974, and reported last year, is off to a good start judging by student and faculty reactions. The new arrangement provides students with a much broader range of choices for their electives in this category in the freshman and sophomore years. At the same time, it takes the almost overwhelming load off the few subjects that formerly were allowed to satisfy the Humanities Requirement.

The communications gap between the humanities, broadly construed, and science and engineering has been a perennial issue and recent efforts to bridge the gap between these "cultures" are most promising. The experimental Technology Studies Program is an important illustration of such an effort. During the past year Technology Studies was transformed from a set of good intentions into an academic program of research projects, colloquia, and planning for undergraduate and graduate subjects to be offered in 1975-76. The primary emphasis is on the historical, social, and political dimensions of science and engineering -- anchoring the intellectual work simultaneously in specific scientific and technological content and in a disciplined understanding of the social change which often attends technical progress. Although the Program's purview includes such diverse disciplines as history, anthropology, sociology, art history, and education, it is focused on increasing our understanding of the role of values in the planning of research, the acceptance, rejection, and use of innovation, the formation of technological communities, and changes which take place in larger communities as a result of technological developments.

Another group, chaired by Professor Elting Morison, has proposed the creation of a major center for examining the problems of a technological society in their humanistic dimensions, examining the influences of science and technology on contemporary civilization as well as their historical roots and their implications for the future. Both undergraduate and graduate students would be associated with these activities, together with postdoctoral fellows and Senior Lecturers who have had a wide range of experience dealing with these problems. The Concourse Program, an alternative route for freshmen, is perhaps the most ambitious ongoing M.I.T. effort to unify the intellectual disciplines represented in the first year. In this program, which accepts approximately 50 first-
year students, the humanities and science subjects are taught in an integrated manner by a group of faculty members drawn from the Schools of Engineering, Science, and Humanities and Social Science. Finally, a new Oral History Program focusing on science and technology has been established. Many of the great figures of contemporary science and technology have been associated with M.I.T. and for many years we have hoped to document their perceptions of the major events in which they have been a part. This new program will, at least in part, prevent the future loss of priceless historical accounts. Equally important, it will provide students with opportunities to merge an interest in history and science.

While serious revitalizing efforts are taking place in the Institute's basic programs, we also can report continued progress in four newer programs which are natural outgrowths of the interests of M.I.T. faculty and students in conjunction with major contemporary issues -- the Harvard-M.I.T. Program in Health Sciences and Technology, the Center for Cancer Research, the Energy Laboratory, and the Division for Study and Research in Education. The Program in Health Sciences and Technology has achieved a milestone in the graduation of its first class. The 25 students admitted for the M.D. part of the Program in 1971, finished in June of the past year. The Program continues to grow and develop and now involves 100 medical students of whom 20 percent are concurrently enrolled in both the M.D. and Ph.D. degrees. The new curriculum, as envisioned at the beginning, has been developed to permit deeper penetration of the physical sciences and engineering into medicine. A spectrum of academic offerings, previously not available, is under way or under development. The special subjects developed and taught for students in the Program are also available to other students, especially the many M.I.T. students interested in health careers or biomedical engineering.

The Program is in the process of establishing medical engineering departments or centers at the Harvard Medical School teaching hospitals to further collaborative efforts between medical staffs and engineers. These departments, like hospital departments of surgery, pathology, etc., will provide new training opportunities for students and represent the recognition of medical engineering as a significant medical profession. The Program has, as anticipated, also facilitated collaborative research involving interdisciplinary teams -- physicians, engineers, scientists -- from Harvard Medical School, its teaching hospitals, and M.I.T. These research projects range from fundamental science to clinical evaluation in human beings. Research programs currently under way or being planned include biomaterials science, cancer radiation therapy, rehabilitation engineering, a biomedical engineering center, and studies of the health effects of energy production.

The Center for Cancer Research, begun two years ago, has grown in size and complexity to the point where it now includes some 70 researchers -- faculty, students, and professional staff, mostly from the Department of Biology -- and occupies specially designed facilities in the Seeley G. Mudd Building which was dedicated in March. The basic research is addressed toward the understanding, diagnosing, and treating of cancer. Experimental research now includes, in addition to work on animal cells and on isolated cells in cultures, research of a fundamental and diagnostic nature on material from hospital patients, particularly on leukemia.

The Center's research is organized in three groups: 1) the Virology Group which is concerned with RNA tumor viruses and with adenoviruses; 2) the Cellular and Developmental Biology Group which studies the process of mutation, changes in cellular membrane protein, and the abnormal expression of various genes in cancer cells; and 3) the Immunology Group which concentrates on studies of specific antigens on cancer cells, on the structure of the antibody molecules involved in the rejection, and on the development of immunological response.
This Center is well on the way to being a major national resource in the understanding of cancer, providing the opportunity for faculty and students from a number of research groups and departments to work together on a major biological and medical venture.

During the past year the Energy Laboratory, now completing its second year of operation, increased its visibility and viability as the focal point of energy-related research at M.I.T. There has been a clarification and delineation of the research areas of the Laboratory, and funding levels have risen appreciably. The Laboratory is now managed as four units with specific research interests: 1) Energy Management and Economics Studies; 2) Nuclear, Environmental and Electric Power Studies; 3) Fossil Fuel Research; and 4) Special Programs (small new efforts, end-use technology, alternate energy technology).

Though the Laboratory is still in a developmental stage, it now has a key role in energy-related activities at M.I.T., and its associated faculty and staff members have made significant contributions to the formulation of national energy plans through both technical advice and policy-related studies. Currently some 55 faculty members from ten departments and all five schools are involved, together with 85 students and 45 technical staff members in a relatively open and effective learning environment in close articulation with other Institute activities.

During the past year an advisory board of energy experts from outside M.I.T. has been established. This board reviews the work of the Laboratory on a periodic basis and brings close working knowledge of energy problems to bear in advising the Laboratory on its current programs and future plans.

The year 1974-75 was also the second year of operation for the Division for Study and Research in Education, another effort to increase the options and opportunities of faculty and students. The D.S.R.E. has a pioneering and difficult role at M.I.T., attempting to develop a research and teaching program in the field of learning based upon M.I.T.'s many special competences (for example, the programs in the brain sciences, linguistics, computers, and artificial intelligence), and related as well to the particular problems of a specialized learning environment such as that at M.I.T. The expectation is to provide a focal point for research and teaching which will contribute to the deep understanding of learning processes in individuals and groups and thus hopefully point the way to more effective educational methods. Administratively, we are seeking to achieve the advantages of an academic department and an interdisciplinary laboratory.

The Division offered a number of regular subjects and seminars during the fall and spring semesters which enabled the graduate students associated with the Division to obtain a broad introduction to its areas of specialization. These subjects also served as electives for undergraduate and graduate students from other parts of the Institute. Eight graduate students were involved in an interdisciplinary Ph.D. program administered by the Division in collaboration with other M.I.T. departments. The number is expected to be approximately 12 next year. In addition, the Division is cooperating in a new Master of Science Program with emphasis on science and education.

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Within the general context of a forward momentum pressing against financial and social constraints there were, as in every year, particular events which by their extraordinary nature deserve special mention. Some are academic, others the result of events in the world around us. We select a few each year for special mention to highlight scientific or technological milestones, to demonstrate the complexity of the world in which the Institute now lives, and to call attention to those new elements which are likely to be part of the intellectual and social history of the Institute for some time to come.
One of the Institute's great strengths is the extent to which faculty and students are involved in extending our understanding of basic science. Fundamental curiosity about the origins of the universe, the nature of matter, the origins of life, and why it all works the way it does, absorbs the energies of many at the Institute today, as earlier versions of those same questions puzzled our forbearers throughout mankind's history. The work continues day by day and occasionally, and often unpredictably, a major breakthrough occurs. One such occurred this year with the simultaneous and spectacular discovery, at the Brookhaven National Laboratory and Stanford Linear Accelerator Center, of a new kind of subnuclear particle -- the 'J' Particle. Professor Samuel C. C. Ting of M.I.T.'s Laboratory for Nuclear Science headed the team of M.I.T. and Brookhaven physicists which found the particle in the course of a systematic search for such phenomena while bombarding a stationary proton target with protons. The 'J' Particle is the first in a series of new and unexpected particles whose properties still elude classification. Its discovery presents a major challenge to theorists in the effort to explain just what the 'J' Particle is.

On November 27, a special convocation was held at the Institute to hear Professor Ting describe his discovery. At that time, Professor Victor Weisskopf described the immediate reaction of the physics community as follows:

Some say it may be a new type of meson carrying a new quantum number called 'charm' by some physicists. Others say it may be the carrier of the weak interaction force within the proton that holds it together. It is most probably not a quark. It just doesn't have the right properties... I subscribe at this time to the statement that it is as yet something completely mysterious coming to us from the world of the subnucleus and nobody knows what it is.

Alcator

The Alcator high density plasma experiment has come to fruition during the past year. After several years of construction and debugging, this unique M.I.T. contribution to the U.S. efforts to understand the confinement of highly ionized plasmas and ultimately how to derive energy from nuclear fusion reactions is now working extremely well. By taking advantage of cryogenic techniques, and other specialized knowledge existing at the Francis Bitter National Magnet Laboratory and elsewhere at M.I.T., it has been possible to build a machine which advanced the art in several important aspects. The machine operates reliably at extremely high magnetic fields over a wide range of current densities and for relatively long confinement times, and has achieved a denser plasma than any other fusion machine of its kind. Among its kind of device, Alcator is now one of the most promising and interesting in the world and experiments with it are having considerable impact on the U.S. plasma confinement program.
A lumni Survey

An important part of M.I.T.'s educational and research mission involves its alumni. We always have sought a strong and mutually rewarding partnership with our graduates. In a time of changing expectations and increased demands on educational institutions, we feel an increasing pull to involve alumni in the life and work of M.I.T. To begin a renewed effort in this direction, we conducted last year a major survey of alumni views and attitudes about the Institute. The Survey consisted of extensive open-ended telephone interviews of a randomly selected sample of several hundred, stratified to be representative of undergraduate and graduate alumni of all ages. The results were remarkable for the scope and richness of alumni opinion and caring about the Institute which they revealed. The findings speak to alumni as individuals, to the M.I.T. Alumni Association as an organization, and to those of us who seek to guide the Institute in its fundamental academic mission.

What we heard first and foremost from our alumni was the view that an M.I.T. education cannot be matched. Most alumni were quick to say that there is no other place like this, and that if they were of college age, they would come to M.I.T. again for the knowledge, the prestige, and the value of learning how to work hard. At the same time, there were some questions raised by alumni about the impact of M.I.T. on their lives while they were students here -- the personal cost of living in what some described as an extremely competitive or austere environment -- a pressure-cooker which left too little time for personal growth and the development of a larger perspective. In that sense, some alumni felt that they may have paid too high a price for the M.I.T. degree.

This concern, which also is voiced by some of today's students, leads us to ask whether we can identify and moderate or remove those experiences which tend to detract from, rather than enhance, the quality of the education our students receive here. We must continue to grapple with this question -- to make the living and learning environment of the campus as educationally and personally fulfilling as possible.

Another insight we gained from the Survey was that while there was a great deal of support among alumni for the developments in educational and research programs -- and a strong interest in M.I.T. -- alumni generally knew relatively little about what goes on at the Institute today. It seems clear that most alumni still view the Institute through the eyes of their experience here as students. While they may speak of M.I.T. as a dynamic, changing institution, most of them continue to hold to the image of their own years on campus.

Is there any way that we can supplement this powerful, attitude-shaping experience, rooted in the past, with a current understanding that will enable alumni to carry with them a living portrait of M.I.T.? Obviously, this is a very important matter to us. For, to a large extent, in the eyes of the world, M.I.T. is and will continue to be what alumni think and say it is.

The only sure way to know the M.I.T. of today is to be a part of it. Many alumni -- as individuals -- have stayed close to the campus by participating in programs and activities at the heart of the Institute, such as serving on visiting committees, screening prospective students, and providing leadership for the Alumni Fund.

The question before us now is how to expand the opportunity for these and many more close ties and working relationships. One obvious area, of course, would be a program of alumni education. We have tried for years to define the educational needs of alumni, but without great success. Perhaps we have had too narrow a model of what lifelong learning might be. In addition to the traditional course and seminar programs, perhaps we need to invent new
models. Some of these may be worked into the new communications programs organized by the Alumni Association under the leadership of James A. Champy, its new Executive Vice President. Other programs might be collaborative activities which bring together alumni, faculty, and students in partnerships where the roles of the teacher and the learner are flexible and interchangeable, depending on the nature of the activity that brings them together.

At any rate, it seems clear to us that the most meaningful involvements of alumni with the Institute will develop when we find more ways to bring alumni into the life and work of the faculty and students who are here today. We hope to be able to report on significant progress in this area soon.

International Programs

For many years M.I.T. has been an international institution. Our programs have benefited from the participation of exceptionally able students from virtually every country in the world, and our foreign alumni now carry increasingly important responsibilities in their homelands. M.I.T.'s faculty members tend to be international in their professional and scholarly orientation and as a result, research projects at the Institute frequently have substantial international implications. The Institute also from time to time has joined in efforts to develop new institutions in other countries. During the past year, substantial projects were undertaken in Iran and in Venezuela. Important contributions of capital were made by several Japanese organizations. Research projects in Brazil and Europe developed in prior years have been continued and the feasibility of M.I.T. working with alumni and others in Spain on the development of a new institution there has been under consideration.

In undertaking any of these international activities, the interests of those faculty members who would be most directly involved in a project have been and will continue to be a major consideration for the Institute. But clearly, concern about the consequences for all those who would be affected, both at M.I.T. and in the country in question, will continue to be an important element in the Institute's consideration of these undertakings. As a result of the growing volume and complexity of M.I.T.'s international activities over recent years and because there is reason to believe the rate of M.I.T.'s activity in this domain may accelerate, we have asked Professor William F. Pounds, Dean of the Sloan School of Management, to be responsible for coordinating M.I.T.'s various international activities. During the year we named an ad hoc advisory committee of faculty and students chaired by Professor C. P. Kindleberger to review the process whereby M.I.T. undertakes international institutional commitments, including especially the process used in connection with a special program developed by the Department of Nuclear Engineering in Iran, and to recommend to us any changes in that process which the Committee believes would be in the best long-term interest of the Institute. The Committee will report its recommendations during the coming fall term.

Phase II, Boston School Desegregation

As the academic year drew to a close, M.I.T. was asked to lend its talents to the amelioration of yet another kind of social problem. In mid-May, Federal Court Judge W. Arthur Garrity issued the so-called "Phase II" desegregation order for the Boston Public Schools.
one part of which required the School Department to seek the help of area colleges, universities, and businesses in developing a more diverse array of educational programs through which young people in Boston might voluntarily choose schools outside their local neighborhood, thereby increasing the racial diversity in each school. Each of 22 colleges and universities was "paired" with a school or school district; the specific request to the Institute was to work with the School Department to develop a city-wide "magnet" technical high school and a city-wide "magnet" technical middle school (grades 6-8) in schools located in the neighborhood of East Boston.

This was an unexpected request and we explored it very carefully. It is clear that we are being asked to help with an educational task for which we have some competence but little experience, and intertwined with that task is a social issue which is highly controversial. After considerable discussion and consultation during the summer months it became clear that involvement in this task would provide an opportunity for those M.I.T. faculty, students, and staff who wished to participate in an effort with considerable learning potential for all participants; that new funds could be sought to defray the costs of such participation; and that there was, in fact, a feeling on the part of many at M.I.T. that this was an important commitment for the Institute to make. We have therefore embarked on a year-long planning process in collaboration with the Boston School Department.

There are, as always, different views within M.I.T. about how large in scale the effort should be, what educational style is most appropriate for schools of this type, what technical subjects are wisest to recommend when the students will enter the job market several years from now, etc. Discussion of such issues is sometimes heated and we think that is a good sign. This is a project which captures the interest of significant numbers of people at the Institute and the diversity of views is an accurate reflection of the diversity within M.I.T. -- diversity which has always been a very considerable strength. We believe that in addition to providing a different range of public service opportunities and contexts for learning, the issues which the project raises are very close to the basic intellectual purposes of the Institute and engagement with them should provide considerable intellectual return to M.I.T. itself.

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During the past few years the Institute has had continuing concern for the objectives and processes of affirmative action. This phrase has come to include essentially all aspects of the task of equalizing opportunities in education and employment for minorities and women, and of increasing their representation on the faculty, in other areas of employment at M.I.T., and in the fields and professions for which we prepare students. It is ironic that this effort reaches its peak of urgency at just the time when universities are experiencing pressures from other quarters that are more intense than at any time since the Second World War. The devastating impact of inflation and the difficulties of obtaining support for the new intellectual ventures which we must undertake if we are to remain true to our charter and our potential, combine to make this a difficult time for the social change implied by the objectives of affirmative action.

We could not have predicted the severity of these pressures on us. Nevertheless, the following paragraphs from the Institute's Affirmative Action Plan express accurately now, as they did in 1973, our commitment:

As a major educational institution, a large-scale employer, and an influence on our society through its students, its alumni, and its employees, the Institute stands committed to the principle of equality of opportunity in employment and in education.
In its most elementary and comprehensive form, our adherence to the concept of equality of opportunity requires that we strive toward a condition in which considerations of race, sex, national origin, and religion are irrelevant as determinants of the access an individual has to opportunities for education, for employment, for achievement, and for personal fulfillment. Rather, the controlling factors in all such matters must be individual ability, interest, and merit...

While the Institute is obliged, as a major Federal contractor, to develop and sustain a program of Affirmative Action, our commitment to these matters transcends legal or contractual requirements. We undertake these actions and adopt these policies not because we are required to, but because it is right and proper that we do so.

The question of progress on our commitment has been much on our minds in recent months, and because both of us have long-standing personal interests in these aspects of the social fabric of M.I.T., we take this opportunity to summarize our thinking on these important matters.

Our feelings are mixed. We look to the past with a sense of both satisfaction at the effort expended and frustration at our inability to reach all of our objectives. We look to the future with a blend of optimism and uncertainty. It is clear that the need for affirmative action programs in the form of "crisis measures" will diminish, as educational institutions move toward a new mode of operation in which minorities and women are better represented and in which inequitable barriers are eliminated. It is equally clear, however, that some of the vexing problems and challenges will be with us at least through this decade and perhaps beyond. Affirmative action steps will and must continue to be taken at M.I.T. and in all other American institutions until equality of opportunity is not only an accepted concept but an intrinsic part of the fabric of organizations.

At M.I.T. the development of programs specifically aimed at increasing the representation of minorities in the student body began in 1968. At that time we admitted about a dozen black undergraduate applicants, including about six who offered convincing evidence of high motivation and of exceptional academic ability, even though their competitive test scores were not high enough to guarantee admission. While this program was of modest scale, it did have the effect of roughly doubling the number of black Americans in the first-year class. Furthermore, it provided crucial first-hand experience with the problems of educating students whose social backgrounds and prior educational experience differed from the usual first-year class.

Beginning with the 1968 academic year we undertook also extensive recruitment of black applicants for undergraduate admission. As a result of these efforts, the corresponding applicant pool increased more than tenfold: from an average of about 30 in 1968 and prior years to approximately 330. We evaluated most of these applicants outside the usual decision process with the intent of admitting those who, on the basis of our best judgment applied to their records as a whole, appeared to have a good chance of successfully pursuing undergraduate programs at M.I.T.

Those students who seemed likely to benefit from a summer of review and a somewhat more gradual transition to the M.I.T. undergraduate environment were invited to take part in a special summer program which has come to be known as Project Interphase.
Our efforts aimed at increasing the number of minority students who would benefit from an M.I.T. education have evolved to reflect the experience we have gained over the past years. We still aim at admitting all those minority applicants who seem to us to have a good chance of doing well here. Project Interphase has changed in detail and in the balance of its activities; it still provides an important and highly valued way of "letting the clutch out gently" for some of the minority students who come here; and we still engage in widespread recruiting efforts to find those who are both interested and best qualified.

As a result of these efforts, the enrollment of minority students in the first year has grown to 4-6 percent of the class (the corresponding fraction for the black American subgroup is 3-5 percent). There has been no significant increase either in the number of minority applicants or in the admitted subgroup in the past few years. In fact, this fall there is a decline in the number of minority students particularly in the black subgroup, just as there was a decline, reversed in the next year, in 1973. The number of minority applicants appears to be quite sensitive to economic conditions and to the general public perception of the job market for scientists and engineers.

The situation of women in the undergraduate student body has improved in important ways in recent years. There has been considerable growth in the number of women undergraduates, from 2-3 percent of the class in the fifties and early sixties to 15-20 percent in recent years. This growth is due in part to the provision of more housing for women and in part to recruitment efforts in the last two years. Since 1971 women and men have been admitted on a strictly competitive sex-blind basis.

The pool of young women who might reasonably become applicants for admission here appears to be quite large. Thus, the proportion of the class that is female may increase as we continue to encourage women to view career opportunities in the sciences and in engineering as attractive professional goals.

Efforts to increase the number of minorities among the graduate student population at M.I.T. began in 1968 as well. Because graduate admissions are decentralized, with each of the 23 departments granting graduate degrees responsible for its own process and decisions, it is difficult to generalize about these efforts. In most cases recruitment has centered on widespread mailings of information about the department, and on personal contacts with professional associates at schools having significant minority undergraduate enrollments. Most departments have admitted minority students in straightforward competition with other applicants. Other organizations, such as the Sloan School and the School of Engineering, have participated effectively in national programs directed at increasing the number of minority students in those fields. In addition, a few departments, such as the Department of Physics, have developed special graduate programs aimed at minority students who would, without special help, be unlikely to be admitted.

As a result of these efforts, the number of minority students in the Graduate School has increased dramatically -- from about 0.5 percent in 1968 to approximately 4 percent in 1974-75. These students are not distributed across the schools and departments in the same proportion as non-minority students. A larger than average fraction are enrolled in the School of Architecture and Planning and a smaller than average fraction are enrolled in the Schools of Science and Engineering.

The number of women in the Graduate School has also increased in recent years. During the period from 1968-75 the proportion of women has doubled, standing now at about 12 percent. This increase is the result both of modest recruitment efforts during the past four years and of an increased consciousness in young women about career opportunities in science-based and engineering fields.
For both minority and female graduate students, financial aid is often a major determinant of the decisions affecting graduate study. Applicants often approach graduate study with a heavy burden of educational debt from their years as undergraduates; many have family responsibilities as well. Consequently, the limited number of first-year tuition scholarships for minority graduate students and the Ida M. Green Fellowships, awarded primarily to women, are of particular importance in these efforts, and more financial resources of these kinds are needed.

With the exception of scholars of oriental origin, very few minority persons or women have served on the M.I.T. faculty until quite recently. While the historical record is not entirely clear in this regard, it appears that there were, in 1968, just three black Americans and fewer than a dozen women in the ranks of the faculty. While these very small numbers are not surprising in fields such as engineering and management (in which the number of doctoral degrees that have gone to women and to blacks has, until this decade, been less than 1 percent) one might have expected a stronger representation of women in the humanities, in the social sciences, and in some of the fields of science.

While our concern with increased opportunities for women and minorities spans the entire range of employment at the Institute, we have placed special emphasis on faculty. The growing numbers of minority and female students at the Institute look for persons of similar background on the faculty both as evidence of a serious and lasting commitment to these issues, and as like-minded associates in an environment which sometimes appears to offer few familiar and comfortable points of reference. Although both the thrust of affirmative action requirements and our own concern for these matters are aimed at developing a society in which racial background and sex are of little consequence in employment and educational opportunity, it is clear that minority and female faculty will be especially needed as models and as mentors for students.

Beyond these considerations, strong representation of women and minorities on the M.I.T. faculty contributes greatly to the richness and diversity of this community. In an educational institution both the expansion of knowledge and the growth and development of individuals depend crucially on personal relationships and associations. In such a setting what one knows and understands, and how one communicates that knowledge is important, but what one is matters as well, and we are persuaded that the Institute becomes a stronger, more effective place as it draws on the full range of human talent and experience.

Our affirmative action efforts in the area of faculty have produced significant changes in the past few years. In 1975 there were 18 black Americans on the faculty. While this number falls well short of the goal we set for ourselves six years ago, it represents solid progress. At the same time the number of women on the faculty has increased to 54, which comes to about 80 percent of our goal. All departments have widened their search for highly qualified individuals and have made special efforts to seek out women and minority candidates. We have, of course, held rigorously to the principle of selecting the best qualified candidate, also recognizing that minority and female candidates frequently bring special and important qualities. We are convinced that these efforts and these appointments have strengthened a faculty which was already among the most distinguished in the world.

These increases in numbers of faculty appointments over the years do not adequately reflect our total effort in seeking out and recruiting faculty, particularly in those fields in which the pools of highly qualified minorities and women are very small. Over the past two years, a number of minorities and women declined firm offers of faculty appointments from various academic departments. Some of these negative decisions came after months of search and patient negotiation. The increase in minority and women faculty came during a period in which there was virtually no growth within the faculty ranks and in which several departments were accomplishing modest reductions in size.
Our record of accomplishment in other employment categories is mixed. While we have met, or come close to meeting, our objectives in the hourly, office-clerical, and exempt areas of employment, we have fallen far short of our objectives in the areas of administrative staff and research staff, particularly with respect to minorities. In the area of research staff the problem is not unlike that of faculty. Until quite recently minorities have been grossly underrepresented in engineering and science, with the result that the relevant pools of qualified persons are small.

Problems and Opportunities

As we appraise our present situation and look toward the immediate future, several areas of concern, and of opportunity are evident:

--First, we appear to have reached a plateau in our efforts to increase the number of qualified minority applicants for our undergraduate programs. We now know that the group of minority young people who have the necessary secondary school background in mathematics and science is quite small in comparison with the entire secondary school population, and it may not be possible to attract to the Institute a significantly larger proportion of that group than we do at present. Consequently, future increases in the number of minority students who pursue careers in engineering and in the physical sciences are contingent on the degree to which young people can be informed about opportunities in these fields much earlier -- probably in junior high school -- and encouraged to study the necessary mathematics and science. Such information and encouragement have, in the larger society, traditionally come from parents and friends, and it is just this influence which is largely absent for minority students as a consequence of the virtual exclusion of minorities from these fields in the past. While it is not clear what role the Institute can play in addressing this problem, we need to be more imaginative in our efforts than just recruiting from the available pool at the high-school level.

--The Institute has always embodied very high standards of performance for members of the faculty. Appointments at all levels and promotions to the senior ranks have been based on effectiveness in teaching and research in a highly competitive environment. Minority and female members of the faculty experience these same pressures for excellence, and strive, as a matter of course, to high standards of personal accomplishment. At the same time, however, these individuals are the objects of a set of pressures that are a direct consequence of their minority and/or female status. They often are prevailed upon to carry committee responsibilities that go well beyond average assignments of this kind, and these assignments are frequently related to equal opportunity or affirmative action matters. They are invariably sought out by minority and women students who look to them for academic,
career, and personal counseling and for succor and evidence of familiar stability in an unfamiliar, sometimes uncongenial, environment. Out of a deep sense of duty most minority and women faculty undertake tutoring and counseling responsibilities that go well beyond either the expectations or the examples of their professional colleagues. Finally, they function in a society in which the residual minutiae of racism and sexism often represent a persistent grating distraction. Thus, while the needs of professional growth and development represent a significant challenge to essentially all young members of university faculties in the present climate of retrenchment, the task is doubly difficult for most of our female and minority colleagues. We have an obligation to be understanding of these pressures and to provide a supportive and sympathetic environment. Several departments address these concerns by insuring that every junior faculty colleague has a senior mentor, who can provide advice and counsel; the central administration has tried to provide a sympathetic ear and to build sufficient support structures for women and minorities.

--It has been clear for some time that some minority members of the M.I.T. community doubt the sincerity and durability of our commitment to affirmative action in employment and education, and that these doubts arise, at least in part, because no black or other minority person serves in a senior position of line responsibility in the administration. There can be no assurance that this situation will change in the near future. Budgetary pressures have caused us to undertake a careful review of all administrative functions and our interest must remain focused on the trimming of functions and on the consolidation of responsibilities. In this climate, shared by most other universities, we must make still further efforts to insure that the perspectives of minorities and women are considered in the evolution of Institute policy and practice, particularly in those situations in which they do not currently participate directly.

--The Institute's commitment to the principle of equality of opportunity in education and employment is intended to produce fundamental change in our internal processes and norms. Such change comes about as the cumulative result of significant small changes in most aspects of our mode of operation, and these in turn require adherence to a variety of new policies and procedures. Some of these changes, such as the requirement that every department prepare and keep current a detailed operational affirmative action plan, or the requirement that new appointments be preceded by adequate documented searches for qualified candidates, including minorities and females, are perceived by some department chairmen and administrative officers as undesirable bureaucratic mechanisms which interfere with the primary tasks of making a strong institution greater. There are, of course, substantial risks associated with the internal mechanics of affirmative action. Procedures can outlive their utility and
become unproductive bureaucratic encumbrances, and the mechanics of change can become counterproductive if they are allowed to undercut the fundamental importance of individual quality and merit in an academic community. We must remain alert to these hazards and be flexible and willing to adapt the specific procedures of affirmative action programs to change the institution to such a degree that the program is no longer needed -- the sooner the better.

These problems and the need to make continued progress toward the objectives for equal opportunity in education and employment that we have set for ourselves are high priority tasks. They compete for attention with the other important tasks which we have mentioned -- efforts to trim budgets, the search for additional resources, the development of new programs and organizations in emerging areas of academic interests such as energy and health, and the continuing challenge of shaping our undergraduate programs to meet the needs of new generations of students. All these programs are important to the future of the Institute; no simple linear ranking of priorities is possible. We must make progress simultaneously on all these issues. This we intend to do.

A most important event of the past academic year was the vote of the Corporation of December 6, 1974, to accept the recommendation of the Corporation Development Committee for a capital campaign that would seek to increase the Institute's endowment for the support of the students and faculty, to provide funds for the continued development of many vital academic and research programs, and to permit the construction of a small number of vitally needed facilities.

Planning for the M.I.T. Leadership Campaign (involving the Chairman and Honorary Chairman of the Corporation, as well as the President, Chancellor, Provost, Vice President for Resource Development, and many other members of the M.I.T. community) gave a special coherence and urgency to last year's review of the Institute's programs and purpose. That review, much more intensive than normal, brought into sharp focus the very special role of M.I.T. in the world of industry, science, and technology and highlighted the many programs at M.I.T. that have relevance to current problems of our society. Our efforts to focus more precisely than is usual on the Institute's special purposes and strengths, its special audiences, friends and sponsors, and on the many vital areas of research in which it is pioneering, made us appreciate afresh the extraordinary world-wide leadership role held by M.I.T. We find in our travels that the M.I.T. style of technical education, broadly defined, its applied research, and its close links with industry and government are admired and emulated all over the world. We are expected to set the direction and pace for the future; hence the name for this new campaign. The responsibility of living up to the varied expectations placed on M.I.T. is awesome but also inspiring.

The plan to expand the resource base of M.I.T. could hardly have come at a more propitious time, for the extraordinary range of fiscal and social problems now bedeviling the nation are reflected, not surprisingly, on the campus. All operations cost more. The new programs in energy, health, materials and natural resources, and productivity improvement, while financed primarily from the outside, require some continuing Institute funds for their effective development. Existing financial resources, even with their normal growth patterns, would be inadequate to simultaneously meet these two major demands. But the normal growth patterns do not now exist. Endowment values have fallen in recent times and endowment income is down for obvious reasons. Budget cuts and controls based upon

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strict economies and staff reductions have served to maintain an acceptable -- if somewhat
pained -- financial posture during the past several years despite the major impact of the
Draper Laboratory divestment, legally mandated administrative functions, the steep es-
calation in energy costs, rampant inflation, and the leveling off of funds available for
research support. However, these pressures leave little funds for academic initiatives,
either needed modernization in existing teaching and research programs, or for the newly
initiated programs.

The Leadership Campaign, with its dual emphasis on the support of faculty through endow-
ment and program development, will insure the dynamism of the current efforts, and at
the same time add to the financial foundations of the Institute so that it can remain a
vigorous, independent institution during the turbulent years that lie ahead. It will require
much attention of the senior officers in the years ahead but it is a commitment of time
that we believe is essential to the continued vitality and well-being of M.I.T.

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In Special Recognition

The individual efforts and distinctions on the part of the faculty at M.I.T. have been many
during the past year. Four members of the faculty were elected to membership in the
National Academy of Sciences; ten members were elected to the National Academy of En-
gineering; and seven were elected to membership in the American Academy of Arts and
Sciences. These elections, and numerous other honors and awards, attest to the continued
high quality of the M.I.T. faculty and to the dedication of its individual members to schol-
arship of the highest order.

Of special note during the year were the appointments of three members of the faculty to
the distinguished rank of Institute Professor: Dr. Morris Cohen, Professor of Metallurgy;
Professor Walter A. Rosenblith, Provost; and Dr. Ascher H. Shapiro, Ford Professor of
Engineering. Dr. Cohen was additionally honored as the third recipient of the James R.
Killian Faculty Achievement Award.

The past year saw several appointments to senior posts that should receive special mention.
Professor Bruce Mazlish was appointed Head of the Department of Humanities, and Professor
Norman C. Rasmussen, Head of the Department of Nuclear Engineering. In addition,
several laboratories and centers at the Institute came under new leadership during 1974-75.
Professor Arthur P. Solomon, Director of the Harvard-M.I.T. Joint Center for Urban
Studies; Dr. Myron Tribus, Director of the Center for Advanced Engineering Studies; and
Professor Patrick H. Winston, Director of the Artificial Intelligence Laboratory.

Several new appointments to senior administrative positions also should receive special
mention. Dr. Thomas F. Jones was appointed Vice President for Research upon the
retirement of Professor Albert G. Hill; Jay K. Lucker was appointed Director of Libraries
upon the retirement of Natalie N. Nicholson; Glenn P. Strehle was elected Treasurer of the
Corporation upon the retirement of Joseph J. Snyder; Dr. Kenneth Wadleigh was appointed
Dean of the Graduate School upon the retirement of Professor Irwin W. Sizer; and Frank
Urbanowski has been named Director of the M.I.T. Press.

The past year also marked the retirement of eight distinguished members of the faculty.
Their years of service to the Institute and to their students will long be remembered and
appreciated. They are Associate Dean Sanborn C. Brown, Professor in the Department of Physics; Professor Harold A. Freeman, Department of Economics; Professor Robert J. Hansen, Department of Civil Engineering; Professor Albert G. Hill, Department of Physics; Assistant Professor Benjamin R. Martin, Jr., Department of Athletics; Elting E. Morison, Elizabeth and James Killian Class of 1926 Professor, School of Humanities and Social Sciences; Professor Irwin W. Sizer, Department of Biology; and Professor Prescott A. Smith, Department of Mechanical Engineering.

Of particular sadness to us during the year were the untimely deaths of several respected colleagues and advisors.

James M. Barker, Life Member of the Corporation, died in July, 1974, after a long illness. During his nearly 40 years of service in the Institute's governing body he served as a wise and spirited advisor. As student, former staff member in civil engineering, counselor and friend to five M.I.T. Presidents, and as a leader in alumni affairs, he played a major role in the life of the Institute.

Bradley Dewey, Life Member of the Corporation, died in October, 1974. Member of the Class of 1909, he was a pioneer in the development and use of synthetic rubber, a distinguished chemical engineer and a leader in the U.S. chemical industry. His interest in the life and development of the Institute was a source of unflagging strength.

William D. Coolidge, a distinguished inventor who developed the modern X-ray tube and the ductile tungsten filament used in electric lightbulbs, died in February, 1975. Member of the Class of 1896, Dr. Coolidge went on to a long and distinguished career, of which the Institute is proud to have been a part.

Antoine M. Gaudin, Richards Professor Emeritus of Mineral Engineering, died in August, 1974, following a long illness. He was an internationally recognized pioneer in the field of process metallurgy, distinguished especially by his research on uranium recovery. Dr. Gaudin joined the M.I.T. faculty in 1939, serving as mentor and advisor to generations of students and younger faculty members until his retirement in 1966.

Warren K. Lewis, Professor Emeritus of Chemical Engineering, died in March, 1975. Regarded as the father of modern chemical engineering, Professor Lewis was known to generations of M.I.T. students as a hard-driving teacher in the adversary tradition, tempered by a soft heart and a rich stock of funny stories. Among his students many have become members of the M.I.T. faculty and distinguished scientists; his influence on all of us and on the Institute has been deeply felt.

William H. McAdams, a pioneer in the field of chemical engineering and Professor Emeritus of Chemical Engineering, died in May, 1975. Together with the late Professors William H. Walker and Warren K. Lewis, Professor McAdams was instrumental in the development of chemical engineering as a distinct discipline.

Major General James McCormack (USAF, Ret.), who served M.I.T. as Vice President for Industrial and Governmental Relations, died in January, 1975. A distinguished public servant, he served with distinction in a variety of crucial posts in a period of rapid change in science and technology.

These men have been outstanding examples of strength and dedication to science and technology in the service of humanity; they will be remembered and honored by generations of their students, friends, and associates.

JEROME B. WIESNER, President
PAUL E. GRAY, Chancellor
Statistics for the Year

The following paragraphs report briefly on the various aspects of the Institute's activities and operations during 1974-75.

Registration

In 1974-75, student enrollment was 8,050, an increase of 162 over the 7,888 enrolled in 1973-74. This total was comprised of 4,136 undergraduate and 3,914 graduate students.

Graduate students who entered M.I.T. last year held degrees from 336 colleges and universities, 210 American and 126 foreign. The foreign student population was 1,412, representing 18 percent of the total enrolled. The foreign students were citizens of 93 countries.

Degrees awarded by the Institute in 1974-75 included 1,027 bachelor's degrees, 856 master's degrees, 107 engineer's degrees, 362 doctoral degrees -- a total of 2,352.

The number of women at M.I.T. both graduate and undergraduate, has increased continuously. In 1974-75, there were 1,111 women students at the Institute, compared with 921 in 1973-74. In September, 1974, 211 first-year women entered M.I.T., representing 20 percent of the entering class. In 1974-75, a total of 232 degrees were awarded to women.

Student Financial Aid

During 1974-75, the student financial aid program was characterized by significant increases in total awards, in loans made, and in the amount of scholarship assistance. The number of individuals assisted increased for the first time in four years.

A total of 1,791 undergraduates who demonstrated the need for assistance (44 percent of the enrollment) received $3,582,814 in scholarship aid and $2,192,268 in loans. The total of $5,775,082 represented an 18 percent increase in direct aid over last year.

Scholarship assistance was provided by the scholarship endowment in the amount of $1,918,629, by outside gifts for scholarships in the amount of $531,162, by direct grants to needy students totaling $617,442, and by scholarship assistance from M.I.T.'s own operating funds in the amount of $376,840. The special program of scholarship aid to minority group students represented an additional $138,741 from specially designated funds. An additional 390 students received direct grants from outside agencies, irrespective of need, in the amount of $854,738. Outside scholarship support thus totaled $2,003,342, a substantial increase over last year's total. A significant portion of the increase was again due to increased funding of the Federal government's grant-aid program. The undergraduate scholarship endowment was increased significantly by the
addition of $1,019,408 in new funds, which raised the principal of the endowment to $22,003,115.

Loans totaling $2,192,268 were made to needy undergraduates. Of this amount $591,073 came from the Technology Loan Fund, $1,592,195 from the National Defense Loan Fund, and the remainder from other M.I.T. loan funds. An additional $400,713 was obtained by undergraduates from state administered Guaranteed Loan Programs and other outside sources.

Graduate students obtained $999,729 from the Technology Loan Fund. Of this total, $410,670 was loaned under the Guaranteed Loan Program and qualified for Federal interest subsidies and guarantees. In addition, graduate students borrowed $76,160 from the National Direct Student Loan Program. The total loaned by M.I.T. to both graduate and undergraduate students was $3,268,157, an increase of $531,824 over last year's total.

Career Planning and Placement

In spite of the continuing recession, the Institute's graduates found their talents generally in demand. Their good fortune intrigued newspaper reporters covering the employment market for college graduates. Hearing about the job offers received by M.I.T. students, they would contrast this with the bleak picture they had been given at other colleges. Then they would reflect a moment and say, "Ah, but M.I.T., of course, is different."

It is a measure of the Institute's reputation that the number of employers coming to interview in the Career Planning and Placement Office rose slightly over the year before. More firms came recruiting than in any year since 1969-70. There was also an increase in recruiting activity at the Sloan School. Salaries paid to graduates in engineering about kept pace with the cost of living, a significant phenomenon in the economic climate that has prevailed for the last few years. The most handsomely rewarded member of the senior class was a chemical engineer who went to work for an oil company in Saudi Arabia. Salaries paid to Sloan graduates rose less sharply than salaries in engineering, but a Sloan degree still held its own as a prized credential.

Demand for Ph.D. degree candidates in fields other than engineering was less strong. The data on the June class still needs to be sorted and analyzed to see how the Ph.D.'s in individual fields fared in the job market.

Considerable attention was given during the year to helping students in architecture. Informal statistics released in April by the American Institute of Architects put the unemployment rate among professional architects at 25 percent. Students in architecture are fully aware of the economic realities, but for many, architecture is the one profession worth pursuing and they will gladly accept any job as a stop gap if it will keep them in touch with the profession. The Career Planning and Placement Office hopes to add a part-time staff member in 1975-76 to expand its help to students in architecture, planning, humanities, and the social sciences.

The Office, in conjunction with the Office of the Dean for Student Affairs, offered a seminar in the fall term in which undergraduates visited professionals at their place of work. The seminar was particularly intended to help students see at first hand the kinds of career opportunity for which M.I.T. offers preparation. The seminar attracted a small but enthusiastic class, including some upperclassmen as well as freshmen, and is being offered again in 1975-76.
FIGURE 1

FINANCIAL AID TO UNDERGRADUATE STUDENTS FROM ALL SOURCES: 1965-1975

Loans

Scholarships
Statistics for the Year

The recession made itself felt in the area of alumni placement. The number of alumni registering with the Office rose appreciably, to some 620 from 557 the previous year, and the number of job vacancies reported to the Office fell significantly. Many registrants said that they had not had to look for a job since they graduated, sometimes 20 years ago. A large portion of staff time was devoted to counseling on career alternatives and approaches to job hunting.

Finances

As reported by the Treasurer, the total financial operations of the Institute, including sponsored research, increased from the level of 1973-74. Educational and general expenses -- excluding the direct expenses of departmental and interdepartmental research, and the Lincoln Laboratory -- amounted to $92,860,000 during 1974-75, compared to $82,962,000 in 1973-74. Reflected in the finances of the Institute was the decrease in the use in operations of unrestricted funds to $4,596,000, compared with $5,309,000 in the preceding year. In addition, the Research Reserve was drawn on in 1974-75 in the amount of $480,000, compared with $2,781,000 in 1973-74.

The direct expenses of general departmental and interdepartmental sponsored research increased from $55,436,000 to $64,992,000, and the direct expenses of major laboratories and special departmental research decreased from $76,989,000 to $74,084,000.

The construction program of the Institute continued to make progress in 1974-75, with the book value of educational plant facilities increasing from $190,029,000 to $197,500,000.

At the end of the fiscal year, the Institute's investments, excluding retirement funds, had a book value of $340,038,000 and a market value of $402,491,000. This compares to book and market totals of $340,866,000 and $388,176,000 last year.

Gifts

Gifts, grants, and bequests to M.I.T. from private donors decreased from $21,406,000 in fiscal year 1973-74 to $20,282,000 in fiscal year 1974-75. The latter figure includes unrestricted direct gifts to the Alumni Fund of $715,000, which constituted part of the total of $3,327,000 reported by the Alumni Fund in 1974-75.

Physical Plant and Campus Environment

Several phased projects were completed during the year. The renovation of the east wing of Ashdown House for graduate students was completed in August, 1974, in time for the students to move in before the beginning of the fall term; the west wing had been completed the previous November. The Seeley G. Mudd Building, including the Cell Culture Center and the remainder of the Center for Cancer Research, was also finished and occupied during the year.
FIGURE 3

THE GROWTH OF M.I.T.'S FUNDS AND PLANT ASSETS, 1974-75

- Total funds
- Total endowment funds
- Educational plant assets
- General-purpose endowment

Fiscal year ending June 30

---

President and Chancellor
The George R. Wallace, Jr. Geophysical Laboratory, described as the best equipped geophysical observatory in the world, was dedicated in May, 1975. The underground observatory in Westford, Massachusetts, is capable of detecting earthquakes anywhere in the world. It also will be used to evaluate earthquake risk in New England and to test seismic instruments before being placed on the moon or other planets.

Work progressed during the year on the Chemical Engineering Building, the West Campus undergraduate house, and the installation of Refrigeration Machine No. 4 at the central utilities plant. This 4,000-ton unit brings the central plant refrigeration capacity to 10,500 tons and represents the last of the original central plant programmed units.

The new 300 student undergraduate dormitory on the West Campus, located on Memorial Drive adjacent to MacGregor House, is scheduled for completion in time for occupancy the last week of August, 1975.

* * * * *
### Personnel Changes

#### CORPORATION

**DEATHS**
- Bradley Dewey
  - Life Member
- Alfred L. Loomis
  - Life Member Emeritus
- Uncas A. Whitaker
  - Life Member Emeritus

**RETIREMENT**
- Joseph J. Snyder
  - Treasurer of the Corporation
  - Ex Officio Member

**CHANGES OF APPOINTMENT**
- Cecil H. Green
  - Life Member Emeritus
- John C. Haas
  - Life Member
- J. Kenneth Jamieson
  - Life Member
- Robert C. Sprague
  - Life Member Emeritus
- Charles A. Thomas
  - Life Member Emeritus
- George W. Thorn
  - Life Member

**ELECTIONS**
- Virgilio Barco
  - Member

**TERMS EXPIRED**
- William S. Brewster
  - Member
- Ralph M. Davison
  - Member
- Luis A. Ferré
  - Ex Officio Member
  - President of the Alumni Association
- Shirley A. Jackson
  - Representative from Recent Classes
- Vernon E. Jordan, Jr.
  - Member
- Norman B. Leventhal
  - Member
- Wilfred D. MacDonnell
  - Member
- Harold J. Muckley
  - Member
- Howard L. Richardson
  - Ex Officio Member
  - President of the Alumni Association
- Glenn P. Strehle
  - Treasurer of the Corporation
  - Ex Officio Member
- Mary F. Wagley
  - Member
- D. Reid Weedon, Jr.
  - Member
- William J. Weisz
  - Member
- James A. Champy
  - Member

**RESIGNATION**
- James A. Champy
  - Member

**FACULTY**

**RETIREMENTS**
- Sanborn C. Brown
  - Professor in Physics and
  - Associate Dean of the Graduate School
- Harold A. Freeman
  - Professor in Economics
- Robert J. Hansen
  - Professor in Civil Engineering
- Albert G. Hill
  - Professor in Physics and
  - Vice President for Research
Personnel Changes

Benjamin R. Martin, Jr.
Assistant Professor in Athletics

Elting E. Morison
Elizabeth and James Killian
Class of 1926 Professor
School of Humanities and
Social Science

Irwin W. Sizer
Professor in Biology and Dean of
the Graduate School

Prescott A. Smith
Professor in Mechanical
Engineering

Walter Wrigley
Professor in Aeronautics and
Astronautics

RESIGNATIONS

Professors:

Richard H. Holm
Chemistry

Jerrold J. Katz
Philosophy

Elliott H. Lieb
Mathematics

Harry L. Van Trees, Jr.
Electrical Engineering and
Computer Science

Associate Professors:

Boruch A. Brody
Philosophy

Huw G. Davies
Mechanical Engineering

Robert F. Engle
Economics

George F. Farris
Sloan School of Management

Roy E. Feldman
Political Science

Michael J. Fischer
Electrical Engineering and
Computer Science

George A. Gorry
Electrical Engineering and
Computer Science

Stephen Grossberg
Mathematics

David A. Kolb
Sloan School of Management

Robert Mehrabian
Materials Science and
Engineering

R. Marcus Price
Physics

Francine F. Rabinovitz
Urban Studies and Planning

Robert J. Taylor
Physics

Vytenis M. Vasyliunas
Physics

Assistant Professors:

Elizabeth C. Altman
Humanities

F. Christopher Arterton
Political Science

Richard M. Britain
Architecture

Boyce W. Burge
Biology

Michael L. Fredman
Mathematics

John Henize
Sloan School of Management

Peter Herman
Humanities

Nancy Jo Hoffman
Humanities

Peter G. W. Keen
Sloan School of Management

Norman A. Kurnit
Physics

William S. Morrison
Athletics

Alan Needleman
Mathematics

Joel H. Spencer
Mathematics

Prabha Sridharan
Mechanical Engineering

Terry A. Winograd
Electrical Engineering and
Computer Science

PROMOTIONS

To Professor:

David Adler
Electrical Engineering and
Computer Science

Jonathan Allen
Electrical Engineering and
Computer Science

Suzanne Berger
Political Science

Aron Bernstein
Physics

Jack B. Howard
Chemical Engineering

Keith H. Johnson
Materials Science and
Engineering
President and Chancellor

Michael Lipsky
Political Science

James D. Litster
Physics

Robert D. Logcher
Civil Engineering

Albert R. Meyer
Electrical Engineering and Computer Science

David H. Marks
Civil Engineering

D. Quinn Mills
Sloan School of Management

Michael J. Piore
Economics

Uttam L. RajBhandary
Biology

Jose M. Roesset
Civil Engineering

Fred C. Schweppe
Electrical Engineering and Computer Science

Michael S. Scott Morton
Sloan School of Management

Jeremy F. Shapiro
Sloan School of Management

K. Barry Sharpless
Chemistry

Nam P. Suh
Mechanical Engineering

Neil E. Todreas
Nuclear Engineering

Donald R. Uhlman
Materials Science and Engineering

Carl I. Wunsch
Earth and Planetary Sciences

Richard K. Yamamoto
Physics

To Associate Professors:

John W. Belcher
Physics

Charles L. Cooney
Nutrition and Food Science

John M. Edmond
Earth and Planetary Sciences

Woodie C. Flowers
Mechanical Engineering

Michael W. Golay
Nuclear Engineering

Sidney M. Hecht
Chemistry

Peter A. Holland
Athletics

Timothy L. Johnson
Electrical Engineering and Computer Science

Paul L. Joskow
Economics

Maria C. Linder
Nutrition and Food Science

Barbara H. Liskov
Electrical Engineering and Computer Science

Thomas L. Magnanti
Sloan School of Management

June L. Matthews
Physics

Ole S. Madsen
Civil Engineering

Stephen F. Moore
Civil Engineering

Suhas S. Patil
Electrical Engineering and Computer Science

Robert S. Pindyck
Sloan School of Management

Jeffrey Pressman
Political Science

David E. Pritchard
Physics

Richard P. Stanley
Mathematics

Donald Y. Sur
Humanities

John B. Vander Sande
Materials Science and Engineering

Jan Wampler
Architecture

Daniel White
Humanities

To Assistant Professor:

Judith Bostock
Physics

Edward Y. Miller
Mathematics

Robert J. Slattery
Architecture

CHANGES OF APPOINTMENT

Alan Altshuler
Professor in Political Science, Urban Studies and Planning, and the School of Engineering

John P. Appleton
Lecturer in Mechanical Engineering
Personnel Changes

Robert C. Armstrong
Du Pont Assistant Professor in Meteorology

Robert C. Beardsley
Visiting Associate Professor in Meteorology

Sylvain Bromberger
Professor and Acting Head of Department of Philosophy

Stephen K. Burns
Senior Research Scientist in Health Sciences and Technology

Elzbieta E. Chodakowska
Assistant Professor in Humanities

Morris Cohen
Institute Professor

Robert E. Cohen
Du Pont Assistant Professor of Chemical Engineering

Stephen H. Crandall
Ford Professor of Engineering in Mechanical Engineering

Ernest G. Cravalho
Associate Professor in Mechanical Engineering and Associate Dean of Engineering for Education Programs

Merton C. Flemings
Ford Professor of Engineering in Materials Science and Engineering

James G. Fox
Associate Professor of Laboratory Animal Medicine in Medical Department, Director of Division of Laboratory Animal Medicine and Research Associate in Department of Nutrition and Food Science

E. Victor George
Lecturer in Electrical Engineering and Computer Science

David C. Gossard
Assistant Professor in Mechanical Engineering

Alan J. Grodzinsky
Esther and Harold E. Edgerton Assistant Professor of Electrical Engineering and Computer Science

Kent F. Hansen
Professor and Acting Head of Nuclear Engineering

Donald R. F. Harleman
Ford Professor of Engineering in Civil Engineering

John R. Harris
Research Associate in Urban Studies and Planning

Wesley L. Harris, Sr.
Associate Professor in Ocean Engineering and Aeronautics and Astronautics and Director, Office of Minority Education

J. Karl Hedrick
Associate Professor in Mechanical Engineering

Albert G. Hill
Senior Lecturer and Professor Emeritus in Physics and Consultant to the President and Chancellor

D. Graham Holmes
Esther and Harold E. Edgerton Assistant Professor in Mechanical Engineering

David P. Hoult
Senior Research Associate in Mechanical Engineering

Joel A. Huberman
Visiting Professor in Biology

Timothy E. Johnson
Research Associate in Architecture

Hubert E. Jones
Associate Professor in Urban Studies and Planning

Thomas F. Jones
Vice President for Research and Visiting Professor in Electrical Engineering and Computer Science and Division for Study and Research in Education

Richard M. Koffler
Research Fellow in Humanities

Alaa Mansour
Visiting Lecturer in Ocean Engineering

Bruce Mazlish
Professor and Head of Department of Humanities

James H. McClellan
Assistant Professor in Electrical Engineering and Computer Science

Philip C. Myers
Assistant Professor in Physics

David A. Oliver
Research Associate in Aeronautics and Astronautics

Frank E. Perkins
Professor and Acting Head of Department of Civil Engineering

Ithiel de Sola Pool
Arthur and Ruth Sloan Professor of Political Science

Norman C. Rasmussen
Professor and Head of Department of Nuclear Engineering

Eugenia K. Rivas
Assistant Professor in Meteorology
President and Chancellor

Edward B. Roberts  
David Sarnoff Professor of Management

Ignacio Rodrigues-Iturbe  
Visiting Associate Professor in Civil Engineering

Walter A. Rosenblith  
Provost and Institute Professor

William J. Shack  
Lecturer in Mechanical Engineering

Ascher H. Shapiro  
Institute Professor

Barbara J. Sirota  
Assistant Professor in Humanities

Arthur P. Solomon  
Associate Professor of Urban Studies and Planning and Director of the Joint Center for Urban Studies

John A. Steffian  
Research Associate in Architecture

Jacques N. Sultan  
Visiting Associate Professor in Civil Engineering

Benson R. Snyder  
Director for Division for Study and Research in Education and Professor in School of Architecture and Planning

Toyoichi Tanaka  
Assistant Professor in Physics

J. Kim Vandiver  
Assistant Professor in Ocean Engineering

Kenneth R. Wadleigh  
Vice President, Dean of Graduate School, and Professor in Mechanical Engineering

Phyllis A. Wallace  
Professor in Management

Stephen G. Waxman  
Visiting Assistant Professor in Biology

Sean Wellesley-Miller  
Assistant Professor in Architecture

Patrick H. Winston  
Associate Professor of Electrical Engineering and Computer Science and Director, Artificial Intelligence Laboratory

Robert K. Yin  
Visiting Assistant Professor in Urban Studies and Planning

NEW FACULTY APPOINTMENTS

Professors:

Janos M. Beér  
Chemical Engineering

Robert J. Birgeneau  
Physics

Fischer Black  
Sloan School of Management

Nicolaar J. Habraken  
Head of the Department of Architecture

Stanley R. Hart  
Earth and Planetary Sciences

Kenneth Keniston  
School of Humanities and Social Science

John E. Meyer  
Nuclear Engineering

Julian Szekely  
Materials Science and Engineering

Associate Professors:

Joan W. Bresnan  
Foreign Literatures and Linguistics

Rudiger Dornbusch  
Economics

David K. Roylance  
Materials Science and Engineering

Raymond T. Schnadelbach  
Urban Studies and Planning

Lothar Wolf  
Nuclear Engineering

Kyu S. Woo  
Architecture

Assistant Professors:

Gregory B. Baecher  
Civil Engineering

Zvi Bodie  
Sloan School of Management

Rowland M. Cannon, Jr.  
Materials Science and Engineering

Flora Y. F. Chu  
Electrical Engineering and Computer Science

Joel P. Clark  
Materials Science and Engineering

Phillip L. Clay  
Urban Studies and Planning

Carlos F. Daganzo  
Civil Engineering

Owen L. Deutsch  
Nuclear Engineering

James W. Driscoll  
Sloan School of Management

Clarence A. Ellis  
Electrical Engineering and Computer Science

Lloyd S. Etheredge  
Political Science

Christos Georgakis  
Chemical Engineering

Frederick L. A. Grauer  
Sloan School of Management

David E. Housman  
Biology
Personnel Changes

Richard O. Hynes
Biology

David G. Jansson
Aeronautics and Astronautics

Charles L. Jones
Political Science

Manohar U. Kalwani
Sloan School of Management

Alcira G. Kreimer
Urban Studies and Planning and Architecture

Yue-Ying Lau
Mathematics

David Lee
Architecture

Steven R. Lerman
Civil Engineering

Raymond E. Levitt
Civil Engineering

Nathaniel J. Mass
Sloan School of Management

Carol D. Meyer
Chemistry

William H. Rastetter
Chemistry

David D. Redell
Electrical Engineering and Computer Science

Richard R. Schrock
Chemistry

Adrian Segall
Electrical Engineering and Computer Science

Edward I. Solomon
Chemistry

Ralph H. Staley
Chemistry

Stephen G. Steadman
Physics

Liba Svobodova
Electrical Engineering and Computer Science

Peter Szolovits
Electrical Engineering and Computer Science

Harry L. Tuller
Materials Science and Engineering

Anne Vernez-Moudon
Architecture

Martha W. Weinberg
Political Science

Andrew Chi-Chih Yao
Mathematics

Gregory J. Yurek
Materials Science and Engineering

VISITING FACULTY

Visiting Professors:

Eytan Barouch
Sloan School of Management

Hans A. Bethe
Physics and Compton Lecturer

Ye T. Chou
Materials Science and Engineering

Geoffrey P. E. Clarkson
Sloan School of Management

Henry S. Commager
Humanities

James M. Douglas
Chemical Engineering

Sheldon L. Glashow
Physics

Albert Haug
Physics

James D. Hedburg
Earth and Planetary Sciences

Lillian Hellman
Humanities

Klaus Hepp
Mathematics and Physics

John Hersey
Humanities

David K. Hsiao
Sloan School of Management

Hansgeorg Jeggle
Electrical Engineering and Computer Science

Karl G. Jungenfelt
Economics

Werner Kanzig
Physics

Shan S. Kuo
Sloan School of Management

Goro Kuwabara
Electrical Engineering and Computer Science

Schneior Lifson
Chemistry

James A. Mirrlees
Economics

David Moizer
Architecture

Robert S. Morison
School of Humanities and Social Science

John R. Moroney
Economics

Lewis Mumford
Urban Studies and Planning

Alva R. Myrdal
Political Science

Judith Nemeth
Physics
President and Chancellor

Howard J. Osofsky
Nutrition and Food Science

Mervyn S. Paterson
Earth and Planetary Sciences

Moselio Schaechter
Chemistry

Bertrand Schwartz
School of Engineering

Hermina Sinclair-de Zwart
Psychology and Division for Study and Research in Education

Valentine Telegdi
Physics

Visiting Associate Professors:

Adam C. Bell
Mechanical Engineering

Robert L. Blakeley
Chemistry

Stuart B. Crampton
Physics

George W. Flynn
Physics

Christoph Haehling von Lansenauer
Sloan School of Management

Nancy J. Kopell
Mathematics

Ian Lerche
Physics

Dieter List
Nutrition and Food Science

Takaaki Nagao
Mechanical Engineering

Parviz Payvar
Mechanical Engineering

William W. Roberts
Mathematics

Allen Sinai
Sloan School of Management

Norman S. Stearns
Sloan School of Management

James T. Woo
Nuclear Engineering

Frank Press
Kilian Award Lecturer for the Academic year 1975-1976

ADMINISTRATION

DEATHS

Malcolm G. Kispert
Institute Secretary

Philip A. Knight
Personnel Officer
Office of Personnel Services

RETIREDMENT

Sanborn C. Brown
Associate Dean
Graduate School

Max M. Byer
Administrative Assistant
Electrical Engineering and Computer Science

Helen M. Clifford
Assistant to the Treasurer
Alumni Association

Ruth L. Dawson
Administrative Assistant for Investments
Comptroller's Accounting Office

Francis E. Haslett
Student Center Librarian Libraries

G. Edward Nealand
Director Purchasing Office

Natalie Nicholson
Director of Libraries

William Speer
Associate Dean
Student Affairs

RESIGNATIONS

Anne A. D. Aylward
Administrative Assistant Urban Studies and Planning

Harvey P. Baumel
Assistant to the Director Programming Development Office

Andrew J. Brown
Administrative Staff Accountant
Comptroller's Accounting Office

Daniel A. Carrier
Administrative Officer Psychology

E. Tatum Christiansen
Assistant to the Director Center for Advanced Engineering Study

Gerald L. Clarke
Manager, Administration and Data Systems Planning
Programming Development Office
Personnel Changes

James H. Eacker
Assistant to the President
Vice President's Office

Kenneth T. Finney, Jr.
Manager of Systems Development
Office of Administrative Information Systems

Patricia T. Gordon
Assistant Science Librarian
Libraries

Carl A. Gregor
Administrative Officer
Mechanical Engineering

Robert L. Hadlock
Head, Acquisitions Department
Libraries

Bradford J. Haley
Assistant Director
Student Financial Aid Office

Lyman R. Hazelton, Jr.
Programming Analyst
Information Processing Center

Anne S. Hirsch
Industrial Liaison Officer
Industrial Liaison Office

Leslie Clift Hruby
Director of Placement and
Assistant to the Dean
Sloan School of Management

Peter Jarvis
Employee Instructor
Office of Personnel Development

Roberta Kurland
Assistant Director
Student Financial Aid Office

James W. Lambert
Director, Development Office
Resource Development

Irene S. Laursen
User Services Librarian
Libraries

Thomas E. Lightburn
Assistant Director
Office of Sponsored Programs

John A. Mims
Assistant Director of Admissions
Admissions Office

Stanton Moody
Systems Planner
Programming Development Office

Martha Morton
Supervisor-Administrative Applications
Information Processing Center

Hilary A. Murray
Circulation Librarian
Libraries

Peggy J. Murrell
Associate
Analytical Studies and Planning Group

Joseph F. O'Connor
Administrative Assistant to the Vice President for Research

Michael G. Petruzzello
Project Manager
Office of Administrative Information Systems

Cheryl A. Reuter
Assistant Dewey Librarian
Libraries

James J. Righi
Systems Programmer
Programming Development Office

Christine Salmon
Journals Manager
M.I.T. Press

Christine C. Santos
Assistant Editor
Alumni Association

Robert A. Schuiteman
Associate Director of Admissions
Admissions Office

Charles J. Sheehan
Director, Industrial Liaison Office
Resource Development

Rosalita Sicherman
Employee Instructor
Office of Personnel Development

Paul N. Stanton
Associate Director
Alumni Association

James Sussbauer
Programming Coordinator
Office of Administrative Information Systems

William J. Sweeney, Jr.
Project Manager
Institute Real Estate Office

Ralph H. Thuftedal
Applications Programmer
Office of Administrative Information Systems

Joseph Toppin
Assistant Loan Officer
for Student Accounts
Comptroller's Accounting Office

Arnold C. Tovell
Editor in Chief
M.I.T. Press

Janet S. Tuttle
Assistant to the Director
Information Processing Services

Robert L. Van De Pitte
Assistant Director
Office of Sponsored Programs
President and Chancellor

Nancy G. Vaupel
Assistant Humanities Librarian
Howard Webber
Director
M.I.T. Press
Arthuree R. Wright
Associate Science Librarian

APPOINTMENTS AND CHANGES

Nelson Armstrong
Assistant Director of Financial Aid
Student Financial Aid Office
Mary L. Atkinson
Assistant Director
Office of Sponsored Programs
Henry B. Barg
Industrial Liaison Officer
Industrial Liaison Office
Jurate J. Barnes
Campaign Room Manager
Resource Planning
Timothy B. Bird
Assistant for Field Work
Office of the President and Chancellor
Robert H. Bliss
District Officer
Resource Operations
Cynthia C. Bloomquist
Industrial Liaison Officer
Industrial Liaison Office
Burton L. Bluestone
Senior Consultant Trainer
Office of Personnel Development
Carol M. Bostick
Staff Accountant
Institute Real Estate Office
Philippa Bovet
Administrative Assistant Mathematics
Dorothy L. Bowe
Associate Director of Financial Aid
Student Financial Aid Office
Kenneth C. Browning
Associate Dean
Student Affairs
Barbara A. Burke
Assistant Director - Science Writer
News Office
Dennis Capps
Systems Programmer II
Programming Development Office
James A. Champy
Executive Vice President
Alumni Association
Elizabeth M. Childers
Assistant Auditor
Audit Division
John David Colley
Graphic Designer in Design Services
Campus Information Services
Francis T. Conroy
Assistant Director
Office of Sponsored Programs
Meredith E. Copeland
Senior Applications Programmer
Office of Administrative Information Systems
Stephen P. Denker
Associate Director/Regional Director of the Alumni Fund Alumni Association
Linda M. Desmond
Applications Analyst
Information Processing Center
Irene R. Dhosi
Employee Instructor
Office of Personnel Development
David W. Dove
Assistant Director
M.I.T. Associates
Thomas B. Duff
Assistant Director
Office of Sponsored Programs
Barbara M. Farquhar
Systems Analyst II
Office of Administrative Information Systems
Elizabeth M. Ferry
Production Manager, Design Services
Campus Information Services
Daniel J. Fingerman
Assistant Director, Alumni Fund Alumni Association
Peter H. Flagg
Assistant Manager for Systems Development
Office of Administrative Information Systems
Kathleen M. Fox
Administrative Officer
School of Humanities and Social Science
Mark Froimowitz
Applications Analyst
Information Processing Center
Deborah W. Gillett
Administrative Assistant Earth and Planetary Sciences
<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Department/Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laura W. Giroux</td>
<td>Administrative Officer</td>
<td>Laboratory of Architecture and Planning</td>
</tr>
<tr>
<td>Lillian H. Guiliana</td>
<td>Administrative Assistant</td>
<td>Office of Vice President for Research</td>
</tr>
<tr>
<td>Stephen J. Gorman</td>
<td>Senior Staff Accountant</td>
<td>Comptroller's Accounting Office</td>
</tr>
<tr>
<td>Nancy L. Haggerty</td>
<td>Systems Analyst II</td>
<td>Office of Administrative Information Systems</td>
</tr>
<tr>
<td>Anne M. Hartung</td>
<td>Assistant Director</td>
<td>Office of Director of Finance</td>
</tr>
<tr>
<td>Rachel L. Hayes</td>
<td>Supervisor, Administrative Applications</td>
<td>Information Processing Center</td>
</tr>
<tr>
<td>Thomas R. Henneberry</td>
<td>Assistant Director</td>
<td>M.I.T. Associates</td>
</tr>
<tr>
<td>Kenneth L. Hewitt</td>
<td>Personnel Officer</td>
<td>Office of Personnel Services</td>
</tr>
<tr>
<td>William D. Hinkle</td>
<td>Director of Program III, Electric Power Production and Environmental Management</td>
<td>Energy Laboratory</td>
</tr>
<tr>
<td>Barbara A. Johnson</td>
<td>Administrative Officer</td>
<td>Energy Laboratory</td>
</tr>
<tr>
<td>Bonny S. Kellerman</td>
<td>Assistant to the Dean</td>
<td>Student Affairs</td>
</tr>
<tr>
<td>Peter B. Kelley</td>
<td>Programmer</td>
<td>Programming Development Office</td>
</tr>
<tr>
<td>Kevin J. Kinsella</td>
<td>District Officer</td>
<td>Resource Development</td>
</tr>
<tr>
<td>Patricia J. Kress</td>
<td>Assistant to the Director</td>
<td>Office of Sponsored Programs</td>
</tr>
<tr>
<td>Kathleen M. Lalor</td>
<td>Senior Staff Accountant</td>
<td>Comptroller's Accounting Office</td>
</tr>
<tr>
<td>Charlotte A. Lathrop</td>
<td>Assistant Director</td>
<td>Office of Sponsored Programs</td>
</tr>
<tr>
<td>Frederick D. Leach</td>
<td>Assistant Programming Coordinator</td>
<td>Office of Administrative Information Systems</td>
</tr>
<tr>
<td>Claudia B. Liebesny</td>
<td>Assistant Director of Personnel Services</td>
<td>Office of Personnel Services</td>
</tr>
<tr>
<td>Lois Levine</td>
<td>Assistant Director</td>
<td>Student Financial Aid Office</td>
</tr>
<tr>
<td>Jay K. Lucker</td>
<td>Director of Libraries</td>
<td></td>
</tr>
<tr>
<td>Marjorie S. Lucker</td>
<td>Administrative Officer</td>
<td>Foreign Literatures and Linguistics</td>
</tr>
<tr>
<td>Lawrence E. Maguire</td>
<td>Associate Director of Financial Aid</td>
<td>Student Financial Aid Office</td>
</tr>
<tr>
<td>Lawrence W. McKinnon</td>
<td>Administrative Assistant</td>
<td>Nutrition and Food Science</td>
</tr>
<tr>
<td>Julia C. McLellan</td>
<td>Associate Director</td>
<td>Admissions Office</td>
</tr>
<tr>
<td>John T. Meehan</td>
<td>Applications Coordinator</td>
<td>Planning Office</td>
</tr>
<tr>
<td>Frank O. Melanson</td>
<td>Senior Systems Analyst</td>
<td>Office of Administrative Information Systems</td>
</tr>
<tr>
<td>Jean E. Morin</td>
<td>Administrative Assistant</td>
<td>Office of the President and Chancellor</td>
</tr>
<tr>
<td>Bernard A. Morris</td>
<td>Administrative Assistant</td>
<td>Civil Engineering</td>
</tr>
<tr>
<td>Thomas L. McCorkle</td>
<td>Marketing Manager</td>
<td>M.I.T. Press</td>
</tr>
<tr>
<td>Maurice McDermott</td>
<td>Senior Applications Programmer</td>
<td>Office of Administrative Information Systems</td>
</tr>
<tr>
<td>Thomas B. McGary</td>
<td>Systems Programmer I</td>
<td>Development Office</td>
</tr>
<tr>
<td>James W. McGurl</td>
<td>Administrative Officer</td>
<td>Nutrition and Food Science</td>
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<td>Lawrence W. McKinnon</td>
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<td>Julia C. McLellan</td>
<td>Associate Director</td>
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<td>John T. Meehan</td>
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<td>Jean E. Morin</td>
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President and Chancellor

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Assistant Director for Administration
Center for Advanced Engineering
Study

Elaine W. Ng
Programming Analyst
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Elizabeth A. O'Brien
Assistant Administrative Officer
Medical Department

John F. O'Brien
Assistant Accounting Officer for
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Comptroller's Accounting Office

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Allan F. White
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Director of Program II, Energy Economics, Management and Policy
Energy Laboratory

Bruce Zabierek
Applications Programmer
Office of Administrative Information Systems

Helenmarie G. Zachritz
Placement Counselor
Office of the Vice President for Administration and Personnel
The continuing success of the Institute in attracting outstanding, energetic, and committed students provides not only a source of gratification to us all but an embarrassment of riches that strains our resources. The high return rates to M.I.T. housing among upperclass men and women necessitate overcrowding; the growing numbers who participate in athletics (up 33 percent over a five-year period) render facilities obsolete; the range and variety of student activities challenge ingenuity in scheduling the finite space available to accommodate them. However frayed tempers become, these are problems to be welcomed as reflections of a vigorous campus community.

The completion in early fall (on schedule) of the New West Campus Houses will obviate the need for emergency housing plans, prepared in the event of construction delays. Upon the recommendation of the Visiting Committee, the Planning Office will undertake a comprehensive study of space needs for student activities so that the Institute can move toward long-range solutions. And improved athletic facilities are in the fund-raising stages.

One of the most gratifying accomplishments of the past year has been the consensus achieved by a student-faculty-staff committee to determine criteria for the choice of a director of the Office of Minority Education, and to sift through a substantial number of applicants for the position, with firm, unanimous agreement on a short list of candidates. An appointment to the position in the summer of 1975 hopefully will provide the basis for a successful program for retaining an increasing number of minority students at the Institute.

A second rewarding effort has been the development of closer relationships between the Office of the Dean for Student Affairs and the faculty and graduate residents, House governments, and managers, such that a number of problematic issues have been joined in open discussion with mechanisms provided for their resolution. Moreover, the housing system now includes the French-German language house as well as Russian House. Both offer interested students unique opportunities for attaining a language fluency that is hard to equal in the absence of foreign residence. It remains a source of pride that, despite space problems, 91 percent of the freshman class was assigned to their first housing choice!

The fraternity program remains healthy and this year saw the reinstitution of a fraternity tutoring program with eight tutors supported jointly by this office and the fraternities.

The undergraduate seminars program included 65 seminars in the fall and 64 in the spring terms, involving 793 and 459 students respectively.

The Office of Preprofessional Counseling, which continues its remarkable success in helping students to attain admission to professional schools, was added to the Dean's Office. Despite the growing numbers of applicants to medical schools nationally, such that less than one in three is admitted, M.I.T. graduates are successful at a rate of almost nine in ten.

We are fortunate to have added two new staff members: Cle vonne Turner, Assistant Dean for Student Affairs, and Bonny Kellermann, Assistant to the Dean for Student Affairs. The staff is now at full complement for the first time in three years. In recognition of their contributions to the office and to the Institute, the following promotions were made: Kenneth C. Browning to Associate Dean for Student Affairs, and Nancy J. Wheatley to Assistant Dean for Student Affairs.
My major source of personal satisfaction in being Dean continues to be the association with the talented, imaginative, and exciting students who enliven this campus. My contacts include: serving as a freshman and premedical advisor, conducting a seminar on career decisions, attending sherry hours for groups of students, attending fraternity and house dinners, having students in my home, and enjoying individual conversations with old and new friends among the graduate and undergraduate students. These activities sustain the energy level needed for the stressful task of budget-cutting and the long hours of administrative responsibility.

For this has been a stressful year. Annual reports by tradition celebrate accomplishment and mute difficulty. In such a context, acknowledgement of problems without ready solutions may be overinterpreted as a portent of dissatisfaction greater than those portrayed. Despite this hazard, it would be unrealistic to ignore the very real tensions that have existed on this campus in the past year.

Economic stringency has affected students, staff, and faculty alike. The Institute, faced with escalating costs and finite resources, has been forced to increase tuition and to set higher equity levels for students despite formidable and continuing efforts to contain operating budgets. More cost conscious than ever, students inevitably respond by challenging the legitimacy of those charges which they feel most immediately, housing, food, and the like. An increasing number are accelerating their academic programs with the aim of graduating sooner, some at a considerable price in academic stress. Staff and faculty, particularly at junior levels, are unsettled by concerns of job security. Loads grow as tasks remain and numbers shrink.

Unpalatable choices lie ahead. If student activities, one of the glories of M.I.T. and an effective cushion against academic strain, are to be supported, direct charges to students may be necessary. Yet, with limited funds, students might opt for nonparticipation, a decision many at the Institute feel would be exceedingly unwise. Similarly, if students are asked to pay directly for the costs of the faculty and tutors in residence, they may well press for the program to be phased out, with the result that a major component of the learning environment will be placed in jeopardy at the very time when a human buffer against stress is most needed.

Finally, crime in the Cambridge and Boston communities has become a growing problem for the campus, signaled this year with the tragic death of one student and the severe beating of a second. Every measure for increased security carries a price in further restrictions to the freedom of movement on and around the campus.

These are indeed challenges that will require the utmost in ingenuity from all involved. It is relatively easy to ride the crest of success in an expanding academic environment; it demands creativity as well as dedication to conserve essential values in a time of retrenchment. Difficult as that may be, it is an honor for us to serve a great institution; the rewards are evident in the growth and maturation of the students whose development it is our privilege to try to foster.

CAROLA EISENBERG

Freshman Advisory Council

Approximately 250 faculty, staff, and graduate students served voluntarily as advisors to the 1,040 freshmen who entered M.I.T. in September, 1974.
Freshman Advisory Council

More than 160 of the advisors had upperclass men and women working with them as associate advisors. The number of advisors rose over the previous year in response to the increased class size, but not in sufficient numbers to permit assigning each advisor no more than his or her preferred number of advisees. Nevertheless, it is encouraging that a sufficient number of advisors was obtained voluntarily in light of the many increasing pressures on all members of the M.I.T. community.

More than half the volunteers (159) were members of the faculty, instructors, or lecturers. Sixteen advisors were graduate students, and the remainder, as in the past, continued to come from a variety of staff positions within the Institute. Feedback from the freshmen about this diverse group of advisors continued to be quite positive. In particular, student reaction to graduate students serving as advisors was examined closely. Freshmen, as well as sophomores who had graduate students as their freshman advisors, were asked to comment anonymously on their personal experience and their feelings in general. The results were uniformly positive. The Committee on Educational Policy (C.E.P.) was asked to endorse the continued involvement of graduate students as advisors, particularly in light of the projected increase in the size of the Class of 1979. Reservations expressed by some members of C.E.P. led to an experiment for the coming year in which graduate students newly serving as freshman advisors would each have a faculty affiliate.

The Freshman Advisory Council (F.A.C.) has been fortunate to have the continued strong and effective support of students -- a few on the payroll, but the vast majority as volunteers. David August, '76, did an outstanding job coordinating the large number of volunteers who ran Residence/Orientation (R/O) Week. Later during the year he conducted an extensive study of orientation, both at M.I.T. and at other schools. His report provides in-depth answers to many of the questions that have been raised about R/O Week during the past few years. Students have contributed extensively to many parts of the Freshman Handbook, contributed time to the Advisory Group, to the chairman of the F.A.C., and, of course, have served as associate advisors.

Academically, the year 1974-75 was similar to previous ones with the important exception of the new Requirement in the Humanities, Arts, and Social Sciences. For the first time, freshmen had virtually no constraints on what subjects they could take in those areas. If they did not wish to take one of the more than 60 subjects that would partially satisfy the Distribution Requirement, they were free to select almost any other subject which probably would ultimately count either toward the Concentration Requirement or the elective portion of the Requirement. Contrasted with previous years, this office received virtually no complaints from freshmen about the humanities requirements. The freshman credit limit, in its second year, continued to be rigorously enforced by the Committee on Academic Performance (C.A.P.). Instructors of freshmen continued to report the same high level of commitment and interest observed in the past few years.

During the fall, Professor Judith Bostock, administrator for Physics 8.01, reported her observation that a relatively large number of students (50 to 80) in that subject were experiencing difficulty in physics, apparently due to inadequacies in their high school preparation, principally in mathematics. During the winter and spring, our staff worked with several students and faculty under the direction of Professor James E. Young of the Department of Physics to develop a plan for helping members of the Class of 1979 with similar problems next fall. The MITHELP Program will be made available to between 50 and 100 freshmen during the first half of the fall term, provided funding is approved and curriculum development proceeds as scheduled.

In December, the M.I.T. Special Committee on Grading reported to the faculty a series of recommendations regarding undergraduate grading, registration procedures, and related matters. Among other recommendations, the committee proposed the continuation of Freshman Pass/Internal Fail, which was approved in April after an F.A.C. opinion poll indicated
that 85 percent of the undergraduates and 60 percent of the advisors favored continuation. The number of students in academic difficulty at the end of the term was similar to previous years: 4 percent received letters from the C.A.P. at the end of the fall term and 4 percent at the end of the spring term. The number of students asked in June to withdraw for at least a term was greater than that of last year (13 compared to 8) but still fewer than 2 percent of those entering in September. The number is somewhat higher than last year because the C.A.P. decided that it was appropriate to ask a student to withdraw without a previous warning if the circumstances seemed to warrant it; the increase does not appear to have any other significance.

Throughout the year, the F.A.C. staff continued to provide considerable support to the Undergraduate Housing Survey begun in December, 1973. As in previous years, the C.A.P. meetings were attended regularly by a member of the staff, as were meetings of the Committee on Admissions and Financial Aid beginning in November. On an experimental basis, a new program in group counseling was initiated jointly with the Counseling Section expressly for the purpose of helping freshmen cope with the pressures of adjusting to M.I.T., particularly if they also encountered significant academic difficulties. The staff continued its efforts to interact with groups of freshmen and with advisors and associate advisors throughout the year. A new series of open houses attracted several hundred freshmen to the F.A.C. office for conversation and refreshments.

As a result of other commitments, Professor Thomas B. Sheridan asked to be relieved of his responsibilities as chairman of the F.A.C. His support and encouragement during the past two years have been very much appreciated. Rather than having a single chairman, the F.A.C. probably will be overseen by a group of three faculty members headed by the Associate Provost, Professor Hartley Rogers, Jr. The group is expected to examine rigorously the present structure of the F.A.C., including its underlying philosophy.

Bonny S. Kellermann joined the staff part time in October, replacing Nancy Wheatley who shifted her responsibilities to the areas of counseling and housing beginning in September. Ms. Kellermann received an S.B. from M.I.T. in 1972 and an M.A. from the University of Chicago in 1974.

The secretarial job-sharing "experiment" continues to prove effective and has been looked at closely, if not as yet copied, by many offices within and outside M.I.T. Susan Baram and Naomi Landau continue to enjoy that position. Marie-France Pierre continues to provide secretarial support to the F.A.C., and Janis Bestul, '76, continues to work part time in the office.

PETER BÜTTLER
BONNY S. KELLERMANN

Undergraduate Seminar Program

The academic year 1974-75 was again an excellent one for the Undergraduate Seminar Program. Participation by both faculty and students remained high, and those who participated were generally enthusiastic about their experiences. During the fall term, 65 seminars were offered. Seventy-one faculty members and 793 students (605 freshmen and 188 upperclassmen) were involved. During the spring term, 64 seminars were offered, with 73 faculty members and 459 students (246 freshmen and 213 upperclassmen) involved. The participation of upperclass students has been encouraged, and their numbers have begun to increase.
Office of Preprofessional Advising and Education

Professor Ernest G. Cravalho, of the Department of Mechanical Engineering, continued through his second year as faculty chairman of the program. With his help, a new phase of the program, the "How to..." seminars, enjoyed a successful first year. There were ten such seminars first term and 11 second term. These seminars have offered a number of first year and upperclass students their first "hands-on" learning experience. We believe there will be continued growth in this area in future years.

NANCY J. WHEATLEY

Undesignated Sophomore Program

The program continued in a low-key fashion to match sophomores and advisors as needed and to provide them with basic information and services. The number of undesignated sophomores decreased considerably, down about 60 in the fall to 162, and down 35 in the spring to 98. It appears that the demand may remain fairly low next year. The informal advisory group for the program deals with those students who are in academic difficulty. The group has not taken steps to set up an expanded set of services like those provided through the F.A.C., although some preliminary discussions have been held.

ROBERT L. HALFFMAN

Office of Preprofessional Advising and Education

On September 1, 1974, the Office of Preprofessional Advising and Education became part of the Office of the Dean for Student Affairs, and Susan Haigh Houpt was appointed Assistant Dean for Student Affairs. The Premedical Advisory Council and the Prelaw Advisory Council continued to provide advice and counseling to students interested in medicine and law.

Early in the fall term, the Preprofessional Advising and Education Office sponsored three separate meetings with students. Professor J. Daniel Nyhart of the Alfred P. Sloan School of Management and the Department of Ocean Engineering, spoke to students interested in law. Dr. Louis Menand III, Special Assistant to the Provost, advised students interested in education. Professor Bernard S. Gould, of the Department of Biology, spoke to those interested in medicine.

In February, there was a meeting for 1975 medical school applicants. At the end of the spring term, two additional meetings were arranged for students applying to medical and law schools for admission in September, 1976. In these meetings, discussion focused on the application procedure but was open for any other matters raised by the students.

Representatives from medical and law schools again contacted this office to arrange visits to M.I.T. for the purpose of addressing students. Representatives from ten medical schools, 17 law schools, and one dental school visited M.I.T. during the year. The students found these meetings informative and helpful in determining the schools to which they would apply.

Professor Gould visited eight medical schools during the spring term, in the Illinois, Michigan, and Ohio areas. Professor Nyhart visited six law schools in Pennsylvania, Illinois, and Washington, D.C., and two schools of public affairs. These visits increased their understanding of the admissions processes at the institutions, and in turn presented information on the
breadth of undergraduate education at M.I.T. Professor Gould and I attended a conference of the Northeast Association of Advisors to the Health Professions in Philadelphia. Professor Nyhart and I attended the annual meeting of the Northeast Association of Prelaw Advisors in Hartford, Connecticut.

Ross Chartoff, co-director of the Teaching Intern Program, and I held a seminar during the spring term designed to aid students in locating and securing teaching positions.

A forum on the legal profession was sponsored jointly by the Office of Law-Related Studies and the Preprofessional Advising and Education Office. Participants spoke on teaching in a law school, patent law, corporate law, serving as a judge, being a solo practitioner, and working as a junior member of a large law firm. The office also sponsored several informal meetings between premedical students and members of the medical profession.

During Independent Activities Period (I.A.P.), the Committee on Preprofessional Advising and Education sponsored a number of offerings. One consisted of several meetings under the general title "Genetics and Society." Individual sessions were titled "Genetic Counseling," led by Dr. Allen Crocker, Children's Medical Center; "Some Genetic Conditions," Dr. Harry Schwachman, Professor of Pediatrics, Children's Medical Center; "Does Molecular Biology Become More of a Hazard than a Promise," Professor David Baltimore, Professor of Microbiology, M.I.T.; "A Biologist Looks at Medical Genetics," Professor Maurice Fox, Professor of Genetics, M.I.T.; "Man-Made Artificial Genes," Professor Har Gobind Khorana, Professor of Chemistry and Biology, M.I.T. Another offering was titled, "Psychosurgery -- Therapy or Threat," and was given by Professor Stephan Chorover of the Department of Psychology. The Law-Related Studies Office, together with this Committee, offered "A Brief Introduction to Law." Finally, three alumni who now attend law school joined M.I.T. undergraduates for an afternoon to discuss their law school experiences.

The Committee on Preprofessional Advising and Education welcomed two new members, Arnold Aigen and Stewart Landers, and said farewell to Loren Dessonville who graduated in June.

In the fall, the office mailed a questionnaire to 434 alumni currently attending medical school. The questionnaire was returned by 202 who shared some of their thoughts and experience concerning their medical education. This information, as organized by the office staff, will be invaluable to students in planning medical school applications.

The office processed 2,647 applications to 110 medical schools. There were 115 S.B. candidates to medical school in 1975, of which 92 (80 percent) were admitted to at least one school. Of the 71 additional candidates, comprised of graduate students and alumni, 31 (44 percent) were admitted. Thirty-seven students submitted 236 applications to 47 law schools. Eighty percent of the applicants were admitted to law school.

SUSAN HAIGH HOUPT
Minority Student Support

Fall Term

The last week of September, during Mary Hope's fall term leave of absence, I assumed my duties as M.I.T.'s Acting Assistant Dean for Student Affairs, with responsibility for minority affairs. This began a challenging and rewarding experience, starting off with the annual meeting of the Visiting Committee.

Minority students were hesitant about my arrival initially, but soon became very warm and helpful as we got to know and work with each other. The first student activity I attended was an intimate and cheery dinner with the Mexican-American students, held in East Campus. This afforded me valuable insights into the concerns that these students were grappling with in an attempt to organize a formal association. Since there are only about 30 undergraduate Mexican-American students, compared with about 150 black undergraduate students at M.I.T., the Mexican Americans are sometimes a forgotten segment, and need more attention and support from the Institute for this reason. While the Mexican-American students at M.I.T. were not successful in establishing a formal organization, they did manage to get together occasionally for dinners, small affairs, and much-needed mutual support.

One of the more meaningful tasks during the fall term was the formation of a joint minority graduate and undergraduate "Steering Committee" that John Turner, Assistant Dean of the Graduate School, and I formed to serve as an advisory and planning group for our two offices. This group was composed of faculty, staff, and student members, meeting bimonthly throughout the term. These meetings generated the following activities: a regular newsletter from the Office of the Dean for Student Affairs and the Graduate School Office; welcoming socials aimed at getting graduate students together with undergraduates, as well as faculty and staff together with students; a questionnaire to poll the needs of minority students; an "Activity Day," in January; a Black Perspectives Seminar, held weekly during Independent Activities Period; a gala and historical celebration of Black History Week, in February, which included joint efforts of the entire M.I.T. black community. During Black History Week, there were films, panel discussions, musical presentations, a series of soul food sales (which raised money for the Black Student Union,) and an exhibit of noted black persons, largely designed and assembled by Florence Saunders with the help of students and Warren Seamans, the Director of Historical Collections at M.I.T.

Organizations such as the Black Student Union, and its tutorial program; the Black Christian Fellowship Group; Black Student Mechanical Engineers ("Black-Me"); Black Architects; the Black Premed Organization; and the "Black 6" (Electrical Engineering) met regularly, invited resource people, and sponsored relevant academic and social support for their peers. Several other departmental student committees have organized informally and are constantly striving to make their M.I.T. experience a more meaningful and productive one.

Several outstanding black students, excelling in academic achievement and service to the Institute, were nominated in December for a nationally known magazine publication, Black Enterprise. Selected and noted for their achievements, in the March issue, were Karen Scott, Rudolph Miller, and Bernard Robinson, all Class of 1975.

I had a total of 147 appointments with minority students during this term, not counting those who dropped in and remained to talk.

CLEVONNE TURNER
Spring Term

Minority support activities designed to enrich the total living experience of minority students, initiated in 1972 and 1973, continued with student leadership during the academic year 1974-75. Students were encouraged to utilize the services of the Dean's Office or other Institute resources.

To help promote positive self image and academic excellence among minority students, particularly blacks, the first predominantly black fraternity was chartered. The Kappa Alpha Psi is a service fraternity with a focus on providing positive role models for youths of the black community. It also gives career guidance and provides the black male student at M.I.T. with opportunities for comradeship with men such as Dr. Kenneth Clark, and others of like stature. Although membership is open to all M.I.T. male students, the fraternity provides an option for black males usually found only on black college campuses.

Academic departments continued support of student groups. Students in Course VI selected Professor Arthur A. Smith as their faculty advisor. Students in Course II continued to benefit from faculty-student interaction.

The Department of Humanities -- mainly the music area -- supported the M.I.T. Gospel Chorus group. The group photograph and news release, which appeared in newspapers throughout the country, served as a positive public relations item for minorities. Responses from persons inquiring about the group were received from as far west and south as California and Louisiana, respectively. The 1975 Gospel Concert benefited the starving people of Portugal's Cape Verde Islands.

The Black Christian Fellowship continues its community service activities, retreats, and fellowship meetings with the United Christian Fellowship, other M.I.T. religious groups, local churches, and college groups in neighboring states.

The Black Student Conference on Science and Technology, held at the students' request, was supported by non-M.I.T. funds from several corporations and companies. The Dean's Office used the occasion to recognize and commend those students whose academic terms and cumulative averages were 4.7 and above. The students used the occasion to award citations and plaques to those persons from the faculty, administration, and student community whom they felt had rendered outstanding service to black students. Citations for service were awarded to Professor Wesley L. Harris of the Departments of Ocean Engineering and Aeronautics and Astronautics; Dr. Floyd Williams of the Department of Mathematics; and to James Turner, '70, now a professor at Morehouse College in Atlanta, Georgia. Plaques for service were awarded to Chancellor Paul E. Gray, Dr. Albert Hill, Dr. Frank S. Jones, John A. Mims, and Mary Hope. Conference registration numbered 448 out of 500 invitations sent. One hundred and fifty high school students interested in science were invited and attended the conference. The registration figure for the luncheon and workshop was 298 persons. Representation was from 14 states, with persons attending from as far away as California, Michigan, Ohio, Louisiana, and Texas. Crispin Hall, '26, was the conference guest of the students.

Projects designed for black students have attracted and included black foreign students. Future plans are to include Spanish-American students. Off-campus attendance to conferences was again supported by the Dean's Office. One premed student was the recipient of this support. The academic progress of minority students continued to be monitored. Students were commended for excelling, and those who needed help were counseled and referred to proper resources.
The Black Student Union Tutorial Program's staff has remained constant while experiencing an increase in student participation. Brad Haley and Karen Scott are to be commended for their participation as staff advisor and coordinator, respectively.

The services of the counseling section continue to be utilized. In the year just past, the following appointments were completed: 178 undergraduate students, 45 faculty/staff, 7 biweekly employees, 3 exempt employees, 17 non-M.I.T. referrals, 13 alumni, 26 graduate students, and 12 parental, for a total of 301. This does not include walk-ins or incidental appointments.

The number of minority undergraduates who received degrees at Commencement in June were: Class of '75, 18 with S.B.s and one with an S.B. and S.M.; Class of '76, two S.B.s; Class of '74, four S.B.s and two with both an S.B. and an S.M.; Class of '73, two S.B.s for a total of 29 black students. Four Spanish-American students received S.B. degrees with the Class of '75, and one member of the Class of '74 received both the S.B. and S.M. degree.

I would like to express my sincere appreciation to Dean Carola Eisenberg for granting me a four-month leave of absence from the Institute to fulfill requirements for early retirement from the New York City Board of Education. I did, however, return throughout the fall term to assist in the freshman seminar on careers, conducted by Dean Robert K. Weatherall, Director of Placement, in conjunction with this office. The seminar, designed especially for minority students, was open to all students.

MARY O. HOPE

Project Interphase

Project Interphase, a summer academic program sponsored by M.I.T., was conducted for the sixth year. The program is designed to assist a group of freshmen who have been judged to be intellectually and personally capable of succeeding at M.I.T., but whose high school background indicates academic weakness.

After studying the academic profiles of the students and implementing the suggestions of an executive committee and planning staff, chemistry classes were added to the required calculus and physics components.

The Interphase Writing Course is an intensive workshop designed to enable students to write clearly, comprehensively, and forcefully for a demanding audience. Class sessions were supplemented by reading conferences and individual weekly tutorials based on each student's writings.

The Study Skills and Institute Resources Course includes methods of study, introductory, general and specific information concerning Institute resources, visits with and lectures by resource persons at the Institute.

The Humanities component retained the basic creative photography and art option. The athletic and recreational activities remained the same as in the previous year.

The 27 participants in the program included 11 black females, 12 black males, two male Mexican-Americans, and two Puerto Ricans. The academic record of the 1974 group paralleled the previous year at the mid-point of the fall term. However, only one student among the 1974 Interphase participants ended the academic year with a very serious record and negotiated withdrawal.
The graduation record of the 1971 group of participants has been approximately the same as
1969 and 1970. Of the 37 participants, 15 received M.I.T. degrees and two of those 15 are pur-
suing M.I.T. graduate degrees. Sixteen are still pursuing degrees at M.I.T., one has trans-
ferred to the University of Massachusetts at Boston, and five have withdrawn from the
Institute.

MARY O. HOPE

Women's Program

As Assistant Dean for Student Affairs, there is considerable overlap between my responsi-
bilities in counseling and in the women's program. About 50 percent of the students I saw
this year in formal counseling were women, while others stopped by to talk informally.

The Class of 1978 had the largest number of women in M.I.T.'s history. Although my evidence
is, of course, impressionistic, it seemed to me that the increased numbers gave positive sup-
port to the morale of undergraduate women. The women of the Class of 1978 seem full of
vitality and have become involved and active in the M.I.T. community; as an example, one
has taken on the task of Residence/Orientation Coordinator for the Class of 1979.

At the beginning of spring term, the first-year women who had received Committee on
Academic Policy (C.A.P.) warnings or Freshman Advisory Council (F.A.C.) letters at the
end of the fall term were contacted and invited to discuss their academic situation. The
majority of these women responded, a small number continued individual contacts with me
or others in the Dean's Office. A larger number joined a spring term group, led by Clevonne
Turner, Bonny Kellermann, and myself, for the freshmen who had experienced academic
difficulty. This activity will be continued, both to help and support women students as well
as to increase our understanding of women's experiences at M.I.T.

The Association for Women Students (A.W.S.) had a number of successful meetings with
women and men students. The group met jointly on occasion with Women in Science and
Engineering and the Women's Forum. There is a real need, especially among women not
in the M.I.T. housing system, for ways to meet each other for mutual support and friend-
ship. Some of the activities were social in nature and attracted a proportionately greater
number of graduate and off-campus students, for example open houses, Sunday brunch,
and a Christmas party. Speakers included: Mary Rowe, Bernice Sandler, Barbara Newell,
Gloria Lubkin, Wilma Scott Heide, Maria Isabel Barreno, Patricia Graham, and Laya
Wiesner. A.W.S. members, in cooperation with the Admissions Office, wrote letters to
women who had completed preliminary but not final applications to M.I.T. for the fall and
telephoned all accepted women students to answer questions about M.I.T. They sent out,
via the Dean's Office, a questionnaire to women faculty, staff, and graduate students at
M.I.T. for the purpose of assembling a revised and expanded list of those who wished to
advise M.I.T. women undergraduates about careers, choice of major, and other interests.
A.W.S. hopes to accompany this list with a booklet of information for women students. My
role in these activities has been to provide administrative support and encouragement, and
some limited financial support.

I was a member of the Committee on Educational Policy (C.E.P.) subgroup on women students,
which met second term. There was an increasing number of requests from women students
to review the report of the Ad Hoc Committee on the Role of Women Students at M.I.T. of
spring, 1972, to see how extensively the recommendations had been followed, and to examine
some areas in depth that required more work or were not examined in the original report.
Women's Program

The advisability of a new ad hoc committee was considered; however, it was learned that Professor Lisa Steiner of the Department of Biology had been asked to chair a four-person subgroup of the C.E.P. to review the position of women students at M.I.T. That subgroup, enlarged to include women students, myself, and others, met several times in the spring to identify issues and will recommend whether an ad hoc committee is needed.

Some limited statistics on women students at M.I.T. are still being gathered. In addition, work continues on a study of the Dean's Office concerning the on- and off-campus living situation of students. Deans Turner, Wheatley, and I are working on statistics and a limited study of withdrawals and readmissions to M.I.T.; special attention will be given to women students. I also served as a member of the Joint Committee of the Wellesley-M.I.T. Exchange Program.

ANNE E. ELLISON

Counseling

The counseling section of the Dean for Student Affairs Office divided its 1974-75 efforts between individual student counseling and direct support of and involvement in academic and administrative programs related to students. The four full-time and two part-time members of the section met primarily with undergraduate students. Direct work with graduate students constituted a minor portion of the individual student counseling. In their discussions with deans, students raised questions and sought assistance and advice about a wide variety of topics. Although academics was the first and most frequently discussed topic, students spoke of and wanted help with the full spectrum of interrelated concerns about their family, residential, social, financial, medical, legal, and career situations. Many were considering or requesting withdrawal from the Institute, readmission after a term or more away, or excused absences from examinations. Although the Dean's Office also has administrative tasks connected with withdrawals, readmissions, and excused absence, conferences with students on these requests primarily involved counseling.

Most individuals came to the Dean's Office on their own initiative or were referred to the office by their faculty counselors, graduate and faculty residents, instructors, fellow students, or members of the student service-related staff. Until the spring term of 1974-75, when Dean Clevonne W. Turner joined the staff on a regular full-time basis, the office had only a limited follow-up and outreach program. Responding to an obvious need, Dean Turner developed and coordinated the section's first follow-up program for students who had experienced academic difficulties.

As part of the section's academic and administrative support, members of the staff participated as ex-officio members of the Committee on Academic Performance (C.A.P.), and the Committee on Discipline. Although a considerable portion of this work was directly related to individual students whose situations were known to members of the counseling staff, the staff's participation also enabled it to remain sufficiently acquainted with Institute and departmental degree requirements, research opportunities, financial aid resources, and other diverse matters that directly relate to student life at M.I.T. This interaction of the section with faculty and administrative groups further developed and strengthened close cooperative relationships between the Dean's Office and faculty counselors, registration officers, C.A.P., Student Financial Aid Office, Student Accounts Office, Registrar's Office, Medical Department, Campus Patrol, and staff members of the housing system. Faculty and staff members gained from their work with the counseling deans a more detailed picture of the impact of issues upon individual students and student groups and how pending Institute decisions are likely to affect these groups.
Pivotal to the counseling section's efforts have been the support programs for women students, minority students, and undesignated sophomores. These programs are discussed elsewhere by Deans Ellison, Halfman, Hope, and Turner.

Deans Wheatley and Bishop participated on Functional Committees of the Staff Classification Study. Both also served on the Dean's Office housing staff and as liaison between the counseling section and the housing system. At the request of the administration, Dean Bishop served as chairman of an ad hoc committee to review and improve communications about readmissions, withdrawals, cancellations of registration, and related changes in students' status.

Personnel

During the first semester, with Dean Hope on leave, Clevonne Turner was appointed Acting Assistant Dean. With a background in psychiatric social service, she enhanced the section's capacity for new programs. In February she was appointed to a full-time staff position. While Dean Ellison was working on a part-time basis during the fall term, Dean Wheatley began to devote part of her energies to counseling. She brought to the group a wealth of knowledge about and insight into undergraduate life and housing-related issues.

With these staff additions and the return of Deans Ellison and Hope to full-time status, the section was no longer understaffed and was able to handle most of the demands and requests placed upon it, and simultaneously to implement new programs in follow-up and group work.

During the spring term Toni Wilson resigned to accept a position at the Harvard Medical School, and Jean Gerlach resigned to marry and take up residence in the Chicago area. We, as well as many students, miss them. In May, Kay Hudock transferred to the Counseling Section from the Preprofessional Advising and Education Office. She will function in a newly created role of coordinating the clerical and secretarial functions for the section. In June, Constance Fogler joined us from the University of Maine at Orono, where she had been a student and member of the Dean for Student Affairs Office.

Jane Brandford, Marie-France Pierre, and Jane Weisberg, who joined the office in previous years, provided the section with much-needed experience and continuity. We were happy to end the year with a full staff of talented, well-trained, and easy-to-work-with secretaries, who added enormously to the office's enjoyment of serving students, faculty, and staff.

JAMES J. BISHOP
ANNE E. ELLISON
ROBERT L. HALFMAN
MARY O. HOPE
CLEVONNE W. TURNER
NANCY J. WHEATLEY

Judiciary

Most of the responsibilities of the Dean's Office in judiciary matters on campus have been carried out by Deans Eisenberg and Bishop. Six essential tasks were performed in this area. First, Deans Eisenberg and Bishop, as ex-officio members of the Faculty Committee on Discipline, actively participated in the Committee's deliberation of policies and procedures.
However, when the Committee considered its conclusions of sanctions on disciplinary cases, the Dean's Office representatives refrained from making judgments on the cases and usually limited their remarks and advice to issues of precedence, procedure, and any mitigating circumstances that were pertinent to the case and appropriate to release to the Committee. Secondly, the office received complaints filed by members of the Institute community against students, determined whether adequate evidence for the complaints existed, and if so, referred the complaints to the appropriate adjudicatory groups. For incidents that took place within residential groups, the House Judiciary Committees generally heard the cases before any administrative action and hearings before the Discipline Committee. In some cases, the office sought to resolve the complaints through discussion and mediations. It should be noted that although the conferences held by the Dean's Office and involved parties may be viewed in part as preliminary investigations, the Dean's Office did not function as an "investigatory" or "prosecuting" arm of the Discipline Committee.

The third task of the Dean's Office was to inform accused students and complainants about the judiciary procedures, possible outcomes, the rights of the involved parties, and available counseling or advisory resources. Students who had disciplinary charges against them were provided a list of individuals at M.I.T. who are familiar with judiciary matters and who might be available to serve as advisors during the proceeding. The office strongly encouraged such students to solicit the assistance of faculty, staff, and student body members who could serve as trusted confidential advisors on the case. Members of the counseling staff were asked by several students to advise and sit with them at Discipline Committee hearings and panels.

Fourthly, the Dean's Office served as a custodian of disciplinary records. When students with notations of disciplinary actions on their transcripts requested or permitted information about these actions to be released to persons within M.I.T. or outside, the office explained the circumstances of the case, and, as was possible in most cases, pointed out that the students had not been involved in subsequent disciplinary matters.

The fifth task consisted of advising the Institute House Judiciary Committees (JudComs) and the Dormitory Council about individual problems within the houses or with their general development of rules and regulations. During the last two years, Deans Eisenberg, Bishop, Browning, Halfman, and Wheatley have had many discussions with such elected student groups. The result has been improved communications and a better understanding of the diverse views and problems of disciplinary matters within the Houses and the Institute. Students feel more comfortable in discussing with the staff behavioral difficulties within their Houses. They have welcomed and wisely used the opportunities for confidential discussions with the staff that did not require identification of involved students.

Sixthly, the Dean's Office has actively participated in the more than three years of consideration by the faculty and administration of substantial changes in the judicial systems at M.I.T. These deliberations included meetings with the Academic Council, C.E.P., Committee on Discipline, House JudComs, Dormitory Council, Corporation Visiting Committee on Student Affairs, and numerous individual discussions with students, staff, and faculty. A key point in these deliberations has been the role of the Dean for Student Affairs. For three years, the office has sought to simplify its role and to be removed from direct involvement with judiciary matters. A year ago, the Corporation Visiting Committee on Student Affairs recommended that the Dean's Office be divorced entirely from the judiciary process. The staff themselves would like to serve only as advisors to the parties in cases, and to meet with the Committee in the discussion of policy matters. This office would be relieved greatly if the Committee on Discipline itself, or another office, were to receive and "process" complaints filed against students. The multiplicity of roles of the office in judiciary matters continues to confuse students and constitutes a barrier between the office and many students who otherwise would use its services and assistance. These deliberations have also
considered ways of providing students with an easily available, trusted, and well-identified source for registering and receiving due attention to their complaints against non-student members of the Institute. The idea that received the most favorable attention was that of a three-person panel of ombudspersons appointed from the faculty.

JAMES J. BISHOP

Academic Follow-Up and Outreach

In early December, a pilot group for freshmen experiencing academic difficulty was held by Ms. Kellermann and Deans Ellison and Turner. By March an outreach program was in progress, aimed at the freshmen who received C.A.P. warnings and F.A.C. letters in January, 1975. Weekly academic support groups were held starting in March; periodic mailings were sent to freshmen and advisors; and individual interviews were greatly encouraged. This resulted in about ten percent of the students experiencing difficulties opting for the group, and a sizable but undetermined number coming into the F.A.C. and/or counseling section of the Dean's Office for individual appointments.

Another task was to design and coordinate some type of follow-up program for the upperclassmen who received C.A.P. warnings in January, 1975. Letters, phone calls, and departmental resources were used in an effort to increase contact between these students, deans, faculty advisors, departmental advisors, and other resource persons in the Institute. A surprising 40 percent responded by coming into the Dean's Office to discuss academics, tutoring, future plans, or just to reassure us that all was going well. It is not known at this time how many utilized other resources. Discussions have begun concerning possible groups and outreach plans for next year between students who receive warnings and the Dean's Office.

CLEVONNE W. TURNER

Student Activities and Governance

The desirability of a formal study of the needs of student community activities for program space described in this report last year was presented to the Corporation Visiting Committee to the Dean for Student Affairs at its visitation on September 27 and 28. Presentations were made by a panel of faculty members representing committees concerned with student community activities, broadly defined; and a panel of graduate and undergraduate student leaders spoke of the programs within their areas of overview. A slide show and discussion by students dealing with the space needs of selected program units concluded the three-part formal presentation of the subject. It is pleasant to report that the study has been endorsed and recommended.

Steven Wallman, '75, President of the Undergraduate Association, continued the efforts of his predecessors for the creation of a Council of Committees that would function as a means of formal communication linking components of student leadership. Several meetings were held during the year with the agendas reflecting issues of student interest. The net impression of participants was that this was a productive step. An attempt to formalize this process and incorporate other changes by "constitutional revision" failed at the elections in April. It is anticipated that the informal Council will continue, while further attempts will be made to rework the changes for resubmission to the Association.
The Finance Committee, the Association of Student Activities Executive Committee, the Nominations Committee, and the Student Center Committee continued their solid contributions to operations and program support. During the year, a concert committee was formed to plan and sponsor concerts and other student social occasions.

The Graduate Student Council, responding to new demands, created a number of functional operating committees to consider, initiate, and implement programming. This new procedure has increased community awareness and understanding of the Council's outreach and has aided in planning and budgeting. The first-time orientation program for new graduate students on September 6, which incorporated a full-day series of events, meetings, and social occasions, including a luncheon picnic in Killian Court, received an enthusiastic response. Plans for a repeat on September 4 this year are well advanced and will include new events and services to assist the entering graduate student with becoming more fully informed and welcomed. During the year, the new graduate student newspaper, The Graduate, made its appearance. It quickly became an important source of communication for graduate student issues.

The student activity units continue to meet student and community needs in a variety of ways. The Lecture Series Committee reported 64,000 admissions to its films this year while it sponsored, alone or in coordination with others, overflow lectures by John Dean and Senator Sam Ervin. The Student Center Committee also reports increased audiences at its midnight movie series. The Musical Theatre Guild enjoyed a spirited response to its production of "1776," and signs are now up soliciting for Tech Show.

Those in attendance at the Awards Convocation in May became aware of the increased interest in recognition of superior teaching and for contributions to education. A new award this year, presented by the Graduate Student Council, is "The Irwin Sizer Award for the Most Significant Improvement to M.I.T. Education." On this first occasion, it was presented to Seth H. Racusen, '74, and Kenneth G. Skier, '74.

As would be expected, all nine recipients of the William L. Stewart, Jr. Award reflected strong contributions to student community service and activities, but it is significant also that the seven recipients of the Karl Taylor Compton Prize also reflected, in part, strong and continuous association and contribution to the community through a variety of student activity and governance units.

During the year, the M.I.T. Chapel was in use for 8 christenings; 109 weddings; 6 memorial services; 37 programs of music; 404 scheduled religious services; and 157 sessions of organ practice. In August, the Reverend Robert Moran, Catholic Chaplain, joined the Religious Counselors group as successor to the Reverend Stanley MacNevin who became Director of the Newman Center at Ohio State University. We express our best wishes to Father Moran for a fruitful ministry among us.

The challenge, as one looks ahead to budget limitations and increasing costs, would seem to be how to fashion low and zero budget programs which will sustain student life quality and provide continuing opportunities for personal growth.

ROBERT J. HOLDEN
Student Center, Kresge Auditorium, and Talbot House

Program production by student activities and other M.I.T. community organizations is increasing. Even though pressures on space are therefore intensified, M.I.T. continues to be a very stimulating environment. The appearance this year of the M.I.T. Shakespeare Ensemble which presented brief scenes in a program at the Chapel and a run of performances of "Twelfth Night" at the Student Center is but one example of growth.

Kresge Auditorium continues to be a focal point for program production, and it is heartening to continue to observe the spirit of cooperation and mutual understanding which prevails among users of this facility as they attempt to share scarce resources. Dialogue is developing on how much Kresge Auditorium should be used by various programming units. The community of users is making a genuine effort to regulate itself fairly and imaginatively.

The Student Center still teems with life. The Student Center Committee, Physical Plant, and the Office of the Dean for Student Affairs have cooperated to develop a computerized information system which will provide data monthly and yearly on Student Center usage. This information will be portrayed and displayed in a variety of formats enabling those who administer this facility to understand better the way in which the student community and the M.I.T. community utilize program space.

Space pressures also exist in the Student Center, and it is an on-going challenge for the Student Center Committee to understand and respond to the needs of its various constituencies. Real progress has been made along this line. The Student Center Committee as a programming operation has also instigated a biweekly dance/party known as the Strats Rat (Stratton Rathskeller). This opportunity for informal, low-pressure social interaction has found a favorable response from the students. Other groups, from the M.I.T. Ballroom Dancing Club to the M.I.T. Student Homophile League, offer periodic dances and parties. A myriad of other organizations, including folk and square dancing groups and various martial arts groups, are thriving.

Use of Talbot House has remained constant even though demand seems to have tapered somewhat. This is a relief to those faced with hard scheduling decisions. Next year, the Talbot House Committee plans to broaden the base of use by M.I.T. groups and to encourage more week-day usage.

This report marks the end of the first year of a new and much younger cooking staff at Talbot House. This well-received staff has made a genuine effort to cook with more natural foods, something which is evidently appreciated. Comments from users continue to be helpful and have resulted in several small program innovations. Among these are a library of mostly paperback books which users take up and leave at the house for people to read, and a Talbot House Log in which groups may record the highlights of their experience for the benefit of future generations. The Talbot House Committee plans to begin dealing with the question of financing the House after the current Rockefeller grant expires in three years. This should be a challenging task, to say the least.

Students, student organizations, and members of the Dean's Office all look forward to the Planning Office study in the area of student community activities which, hopefully, will be a genuine stimulus to life in this area of the Institute.

JON HARTSHORNE

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Fraternities

The reawakening within the fraternity system continued to be evident through the 1974-75 academic year. The Interfraternity Conference (I.F.C.) became still more active and involved in substantive issues and problems. The Alumni Interfraternity Conference (A.I.F.C.) picked up growing interest and support. The individual houses demonstrated increased social awareness and greater overall responsibility. Rush was very successful with a total of 382 pledges, including 18 transfer students.

Delta Psi (Number Six Club) began a full-scale renovation on their house at 428 Memorial Drive. Progress to date indicates completion prior to the 1975 rush week. For the 1974-75 academic year, the house members resided in two apartment houses on the Cambridge-Somerville line. Spirit seemed to remain high through this exile. The house anticipates a substantial loan from the Independent Residence Development Fund (I.R.D.F.) to make the financing package feasible.

The I.F.C., ably led by Chairman Peter Mancuso, '75 (who received the Fassett Award and a Compton Award), worked to establish better communication among fraternities and between fraternities and the Institute Houses. The problems of rushing black students, blacks in fraternities, and relations with the Black Student Union (B.S.U.) were examined at some length. Also, an effort was made to increase the awareness and sensitivity of fraternity members toward gay members and prospective gay members. The new I.F.C. officers have continued the upward surge of the I.F.C. by revitalizing the collective buying program and working to enhance alumni relations programs. Relations with the Back Bay/Boston Community are still tentative, but the Neighborhood Association of the Back Bay has made the I.F.C. Community Relations Chairman a director of their association so communication at that level is good.

This fall, the A.I.F.C. conducted a series of discussions, with three to six houses in each, and concluded the year with a very successful workshop in May.

The Physical Plant Department has continued its excellent and thorough physical and safety inspection program (coordinated by Howard F. Miller), inspecting five houses this past year with another five or more waiting in line for next year.

This year saw the reinstitution of the Fraternity Tutor Program, with eight tutors being supported by the Dean's Office with matching funds from the houses.

After several years of effort on their part, Pi Kappa Alpha was given approval by the Dean's Office for their becoming a coeducational living group. Unfortunately, they were unable to obtain a reasonable nucleus of upperclass women and will delay going coeducational until at least January, 1976.

The M.I.T. (Epsilon Theta) Chapter of Sigma Nu was separated from the national fraternity this year but has continued to operate as Epsilon Theta fraternity and is in the process of drawing up a new Charter.

The need for replenishing the I.R.D.F. remains before us. With one fraternity (Delta Psi) completing a major capital project requiring funding, with at least one other house seriously interested in a capital project, and with several houses starting long-range planning efforts, the projected need of $10-12 million over the next ten years (with a lesser amount necessary
within five years) is a need which must be addressed. Fortunately, the I.R.D.F. has been included in the Leadership Campaign, and we are hopeful of an early success in beginning to meet this need.

This was a good year for fraternities at M.I.T. The priorities for the future are clear and include social reinforcement, physical improvement, and capital support.

KENNETH C. BROWNING

Institute Houses

Undergraduate Housing

The undergraduate Institute Houses continue to have a surplus of applications over spaces, resulting again in overcrowding and a substantial unmet demand for housing. Hardest hit by the unavailability of on-campus housing are transfer and readmitted students. In an effort to better understand the situation of these students who must live off-campus, the Dean's Office has conducted an extensive housing survey. As a result of this survey and of the apparent needs, we hope to redistribute our efforts in order to better support off-campus students.

Return rates to the Institute Houses continued to be high -- with rates of 98, 90, and 77 percent, respectively, for sophomores, juniors, and seniors (compared with rates of 95, 89, and 85 percent for the previous year). The drop in the rate for seniors may be the result of an increasing rate of early graduations. The larger-than-anticipated freshman class of 1,041 necessitated crowding the Houses by 50 to accommodate all freshmen. This year, also, a record number of freshmen were accommodated in their first-choice Institute House -- an amazing 91.7 percent. The distribution of freshmen at the start of the year was:

<table>
<thead>
<tr>
<th>Institute Houses</th>
<th>650</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fraternities and Student House</td>
<td>369</td>
</tr>
<tr>
<td>Off-Campus (commuters, married, etc.)</td>
<td>22</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,041</strong></td>
</tr>
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</table>

Construction on the New Undergraduate House has proceeded well, and we expect to have available all 300 beds for the beginning of the fall term, 1975. One hundred and four upper-class students have signed up to reside there (including Russian, French, and German houses). This year about 65 spaces in the renovated Ashdown House were used for undergraduates, pending the opening of the New House, in order to achieve the desired freshman class size. This resulted in the creation of two new living groups -- French/German House and Ashdown/New House. The latter had a one-year life as a staging area for students who planned to move to the New Undergraduate House as part of the starting nuclei of those living groups. French/German House -- modeled after Russian House as an opportunity for students to gain a speaking knowledge of French or German and an acquaintance with the appropriate culture -- was quite successful and will continue in a portion of the New Undergraduate House.

In order to realize an increase of approximately 100 in the undergraduate enrollment for 1975-76, the target for the size of the freshman class entering in 1975 was set at 1,130 to 1,150. This will necessitate crowding of 30 to 50, besides completely filling the New House. If undergraduate enrollment continues to climb, additional housing capacity will be required. Increased crowding and/or use of Random Hall are the most apparent options.
Throughout the Institute Houses an increase in student responsibility and involvement was apparent. Judicial systems have been rejuvenated and a committee of students, deans, and housing staff members, chaired by Professor M. Nafi Tüksöz, Senior Faculty Resident of Baker House, completed a review of Institute House regulations -- particularly controversial ones dealing with pets and permanent guests. Increased student concern also has been evident in the extremely high interest in orientation.

The inevitable increase in housing rates for 1975-76 was reviewed by students through the Rate Review Committee. This year's average increase was 9.4 percent in the undergraduate Houses.

Next year, the Food Service will offer a new Commons option which will allow a student purchasing a partial Commons plan to vary the mix of breakfasts, lunches, and dinners to be covered by the plan through the use of points which are "spent" as each meal is taken. Thus, a student next year can take dinners only, for example, if that is desired. The 19-meal Commons option was successful and will continue, as well as the standard 15-meal plan. Price increases in Commons will average about 9 percent.

Graduate Housing

With the help of Professor and Mrs. Robert Hulsizer, Ashdown House took on a new appearance. There was greater interaction among members of the House through regular coffee hours and dinners at the Hulsizers' apartment. Student interest in the governmental structure has grown. The Ashdown House Executive Committee has shown more willingness to take added responsibility. Of particular concern has been welcoming new residents to the House and helping them make Ashdown their home.

Tang Residence Hall seems to have reached a steady state after three years of operation. Although there is a government in Tang, it is not yet well established and may have problems in the future. Although there have been some improvements, there continue to be problems because of lack of interaction among residents and the resulting lack of a sense of community.

Married student housing continues to be in short supply, although the demand for two-bedroom apartments has dropped off. The waiting list remains in the low hundreds, and the wait for a one-bedroom apartment can be as long as a year. Concern has been expressed on this issue.

Some rents in graduate and married student housing have gone up for the coming year. Although Tang Hall will experience no increase, Ashdown rents will go up an average of 4 percent for the coming year. Eastgate rents rose 9 percent in March and will rise another 1.9 percent in September. Westgate rents will rise 1.6 percent in September.

Faculty and Graduate Residents Program

The Faculty and Graduate Residents Program continued to gain support from the students and has become an important part of Institute House life. The understanding, dedication, time, and energy which the faculty members and graduate students and their spouses bring to this program is deeply appreciated. Monthly discussions with faculty and graduate residents have enabled us to maintain a communication flow beneficial to all.
This year, we were pleased to welcome Robert and Carol Hulsizer as Faculty Family in Residence in Ashdown House and William and Diane Thilly as Junior Faculty Family in Residence in MacGregor House. Professor Hulsizer is in the Department of Physics; Professor Thilly is in the Department of Nutrition and Food Science.

KENNETH C. BROWNING
ALICE M. SEELINGER
NANCY J. WHEATLEY

Foreign Study Office

In June, 1974, Professor William N. Locke retired after serving as Foreign Study Advisor for two years. The administrative responsibilities for the Foreign Study Office were subsequently divided between the Dean for Student Affairs and the Dean of the Graduate School. Robert L. Halfman, Associate Dean for Student Affairs, was appointed Foreign Study Advisor. In this capacity he is responsible for the Junior Year Abroad, Domestic Year Away, and I.A.P. Exchange Programs. Sanborn C. Brown, Associate Dean of the Graduate School, was appointed Chairman of the Foreign Scholarships Committee and Fulbright Program Advisor. Dean Brown is responsible for the various foreign graduate scholarship competitions such as Churchill, DAAD (German Academic Exchange Service), Fulbright-Hays, and Marshall. In these times of budgetary stress, M.I.T. offices are asked to evaluate and measure the services they provide. One indication of the value of the Foreign Study Office is the number of persons who come into the office seeking information and assistance during the year. An average of four persons came daily into the Foreign Study Office during 1974-75. Each spent approximately 20 to 30 minutes talking with the Foreign Study Advisor or Assistant about their future goals. Many of these students returned an additional four or five times during the term to discuss the progress of their plans and to request further help. Two additional demonstrations of the value of the Foreign Study Office are: 1) the 33.33 percent increase in the number of students studying abroad during 1974-75 as compared to 1973-74, and 2) that two students received full Fulbright-Hays Graduate Grants for Doctoral Dissertation Research Abroad. This is the first time since 1968 that an M.I.T. student has received a Fulbright-Hays grant for graduate study.

Junior Year Abroad

Twelve M.I.T. students participated in the Junior Year Abroad (J.Y.A.) Program during 1974-75. These students studied in the following countries: England, France, Israel, and Russia. Five of the students joined semester programs, versus full-year programs. The Foreign Study Office has noted an increase in the number of students wishing to spend single terms abroad. This is due to the amount of time that students feel they can be away from M.I.T. and, particularly, from their major area of study. Traditionally, most participating students take their Humanities requirements abroad. In addition, a full year of study abroad requires advanced planning, as early as the first term of freshman year. However, many students do not begin thinking about going abroad until the end of their first year and do not start serious planning for their year away until they are sophomores.

The Foreign Study Office offered several activities during the year to generate interest in study abroad and to keep students informed of the opportunities available for study abroad. One such offering was a "covered supper" which took place last September. The supper was held for returning junior-year-abroad students and for those planning to go away during 1975-76.
Foreign Study Office

Twenty persons attended. Students planning to study abroad got advice from returning students on such matters as expenses, housing, and travel. The office has attempted to encourage "peer advising," as we feel that former J.Y.A. students have a wealth of knowledge and experience to share.

During I.A.P., the Foreign Study Office conducted four seminars on studying, living, and teaching abroad in England, France, Israel, and Scandinavia. As in previous years, faculty members and students who had been abroad were invited to tell of their experiences. Approximately 25 to 30 people attended each seminar which was followed by a refreshment period for a more informal interchange.

Domestic Year Away

Four students participated in the Domestic Year Away Program. The students attended Case Western Reserve University, Cleveland, Ohio; Boston Conservatory of Music, Boston, Massachusetts; Telshe Yeshiva-Rabbinical College of Telshe, Wickliffe, Ohio; and the University of Michigan in Ann Arbor.

The Domestic Year Away Program is still an experimental program of the Committee on Educational Policy (C.E.P.). In May, 1973, the C.E.P. decided to continue the program as an experiment, "... pending conclusion of a more general examination of credit, residence, and exchange issues."

Independent Activities Period Exchange Program

One exchange was arranged during the January, 1975 I.A.P. The exchange was between an M.I.T. student and a student from Middlebury College, Middlebury, Vermont. M.I.T. and Middlebury both waived the tuition and application fees, and the students, with permission of their respective schools, exchanged living quarters. The students were responsible for providing their own meals.

Graduate Fellowship Programs

The Foreign Scholarship Committee is appointed by the President; its membership is eight regular faculty members, two associate faculty members, one graduate student, and a staff assistant. The Chairman of the Committee is an ex officio member. The Committee conducts interviews with applicants for the various international scholarships, such as the Churchill, DAAD, foreign government grants, and Fulbright-Hays Grants; selects and nominates two M.I.T. students for the Churchill Scholarship Program; and selects and nominates one principal and one alternate candidate for the DAAD scholarship.

The Foreign Scholarship Committee is pleased to report that two M.I.T. graduate students in the Department of Political Science received full Fulbright-Hays Grants for doctoral dissertation research in Europe. The students are Robert Berrier and Judith Chubb. Ms. Chubb also received the Social Science Research Council's Western European Fellowship. She will accept the Fulbright-Hays Grant which will be supplemented by the Council's Fellowship. This supplement will allow Ms. Chubb to spend 12 months in Italy conducting her doctoral dissertation research, as opposed to the nine months usually given under the terms of the Fulbright
Grant. It is significant that 33 percent of M.I.T.'s applicants for the grants passed the preliminary or national competition this year and that these candidates' folders were then forwarded to the country of application for the binational competition. This represents a 200 percent increase over last year's preliminary competition.

The German Academic Exchange Service (Deutscher Akademischer Austauschdienst, DAAD) awarded three M.I.T. students full scholarships for graduate study in Germany during the 1975-76 academic year. This is the first time that M.I.T. has received three direct scholarships (as compared with two last year and one in a previous year). Those receiving the DAAD scholarships are Salvador V. Caro, Jr., G, Department of Chemical Engineering; Charles Goodrich, G, Department of Physics; and Lawrence Moss, '75, Department of Chemistry.

The Churchill Foundation awarded Stanley Brooks, '75, of the Department of Mathematics, a scholarship for graduate study at Cambridge University during 1975-76. Unfortunately, Mr. Brooks had to decline the Churchill in order to accept a McCormick Graduate Fellowship at the University of Chicago. This year, the Committee was involved in two new competitions. The first was the Toyota Fellowship Program administered by the Institute of International Education. M.I.T. nominated two women graduate students from the Departments of Architecture and Nutrition and Food Science, but unfortunately neither candidate received a grant.

The second competition was the Office of Education's Fulbright-Hays Faculty Research and Doctoral Dissertation Research Abroad Programs. The M.I.T. Departments of Economics and Political Science asked the Chairman of the Foreign Scholarship Committee, as M.I.T.'s Fulbright Program Advisor, to submit the Committee's nominees to the Office of Education. The candidates, Professor Martin Weitzman of the Department of Economics and James Barber, G, of the Department of Political Science, both received Fulbright awards for study in Russia. The rules require that they also apply to the International Research and Exchanges Board for a grant; both were successful. In addition, Professor Weitzman received an award from the National Academy of Sciences.

Members of the Committee have been attempting to find new ways to publicize and to generate interest in foreign scholarships for graduate study abroad. This has not been an easy task. Advertisements were placed in Institute publications, and seminars on various grants have been offered. During I.A.P., a program on grants for graduate study abroad was given with speakers from the M.I.T. faculty and student body and representatives of various international organizations. The German Consulate General of Boston and the Information Officer of the British Consulate General of Boston also spoke about scholarships for study in their respective countries. Sixty-six persons attended the seminar, nearly triple the projected attendance.

Letters have been sent to 250 faculty members, graduate registration officers, and department heads describing the Fulbright-Hays competition. It is hoped that the letter will provide general information on the Fulbright program and encourage support in helping the Committee to identify interested and qualified students.

SANBORN C. BROWN
ROBERT L. HALFMAN

Department of Athletics

The past year will be remembered as a period of streamlining all phases of programming and operating procedures within the Department of Athletics in the face of two impacting forces: increased programming requirements, and the continued escalation of operating expenses --
both forces coming at a time when the Department was facing up to its responsibility of meeting the Institute's goal to reduce an operating deficit.

The process involved a soul-searching evaluation of ways and means to retain our philosophy of providing as varied a program as possible in athletics and recreation for all students at all levels of interest, including opportunities for quality instruction through the physical education curriculum. It is clear that the achievement of the goals related to this philosophy will require a continuing evaluation of procedures and a close integration of all resources available to the Department -- personnel, physical plant, and operating dollars.

The increase in programming requirements is directly related to: 1) the Department's commitment to equal opportunity in competitive athletics for an increasing number of undergraduate women, 2) a continuing diversification of sports and recreational interests among all students, and 3) a phenomenal interest among all members of the M.I.T. community in sports and recreation as a means toward a healthier, happier, and more productive life.

In addition, a large segment of undergraduate men and women (20 to 25 percent) make a sustaining commitment to varsity and sub-varsity athletics. This particular group strongly expresses the values it associates with this aspect of the M.I.T. athletic program -- the friendships developed, the feeling of belonging, as well as the break from the pressures of academics. At the same time, their desire to achieve is not less here than in the classroom. The daily commitment of this sizable group of students places a heavy demand on all the resources available to the Department.

Following extensive discussions among staff and student leadership within the structure of the M.I.T. Athletic Association, the plan which evolved in response to the need for streamlining operating procedures was based fundamentally upon further consolidation and integration of all services and resources essential in the total program: physical education, intercollegiate athletics, intramurals, club sports, and recreation.

Specifically, those services and program requirements where further streamlining could be effected included:

1) Realistic definition of sports seasons, with beginning and terminal dates for in-season competition, thereby scheduling the fall, winter, and spring seasons to make maximum use of coaching staff in terms of each individual's seasonal assignment over the nine months of each academic year.

2) Integration of scheduling patterns for the 27 men's and women's varsity teams and the four women's club teams enabling, wherever possible, two or more teams to travel in common carriers at charter rates to away contests with traditional New England colleges.

3) Reduced radii of travel and adjustment of game times to enable our teams to travel to and from away events without the expense of overnight lodging.

4) Utilization of campus dining facilities, wherever possible, as opposed to commercial dining.

5) Further standardization of specific items of equipment, uniforms, and supplies used throughout the program to permit bulk purchasing, make replacements most economically, and enable shared use of same equipment pool, wherever feasible, including similar items.
used by the men's and women's teams (warm-up suits, basketballs, etc.).

6) Elimination of the use of "game items" during informal out-of-season practice.

In summary, the bulk of the streamlining projected for 1975-76 is in the area of intercollegiate athletics. In substance, significant savings were not available in on-campus intramural athletics and recreational opportunities for the large numbers of student and faculty-employee users. The latter make effective use of the same facilities and the same pool of equipment at relatively little added expense.

A review of the highlights in each of the program areas described in the remainder of this report will substantiate the increase in programming requirements and the Department's commitment to equal opportunity for both sexes, particularly in competitive sports where there has been a rapid growth in the number of new teams to be accommodated in the scheduling of facilities, staff, and the allocation of operating dollars.

It should be noted, however, that we will continue to have major problems in providing adequate space for all potential student user groups during the popular hours of late afternoon until the completion of the renovations in Rockwell Cage and the du Pont Gym, and construction of the new ice rink-field house, in connection with the long-range plan for the development of the Institute's athletic facilities. This is particularly true at the du Pont Athletic Center where, presently, there is insufficient space to accommodate men's and women's teams in basketball, gymnastics, and volleyball. To meet this problem, it is necessary to operate volleyball in an abbreviated fall season to make the same space available for basketball and gymnastics during the winter months. Typical of the spirit of "give and take" which prevails in similar space constraints, the volleyball clubs of both sexes continue to operate with reduced schedules in the winter months by scheduling occasional contests at nearby Greater Boston institutions or at home when our basketball and gymnastics teams are "on the road." Their practices, however, must come on Saturday and Sunday mornings or at other off-peak hours.

There are similar problems in meeting other programming requirements during this period of growth and fiscal constraints. However, the problems are shared among the teams of both sexes.

The Department recognizes an urgent need for additional full-time female staff, and our Affirmative Action Plan calls for strengthening in this area during the coming year. Meantime, the women's teams are receiving comparable quality coaching, comparable facilities, comparable equipment, and comparable services in every respect.

Pledges have been received in the amount of $140,033 as of May 31, 1975, toward a budget of $212,000 for the expansion and renovation of the Sailing Pavilion. A prototype of an improved Tech Dinghy is being constructed this summer for testing prior to the replacement of the existing fleet planned for spring of 1976. Grateful acknowledgement is made to George Warren Smith, '26, Chairman of the Sailing Pavilion Committee.

Also, the schematic design phase of the new ice rink-field house events center is progressing well with coordination by the Planning Office.
Department of Athletics

Program Highlights for 1974-75

Physical Education

There were 6,882 registrations in 46 subjects offered in Physical Education this past year, including five subjects offered only during Independent Activities Period (I.A.P.).* This represents an increase of 846 registrations over the previous year -- the fifth consecutive year of increases which amount to a growth of 78 percent over the five-year period. Much of the growth can be attributed to non-credit registrations among graduate students and staff.

Table I presents a five-year summary of registration statistics including an analysis of non-credit registrations in (c) which reflects a 360 percent increase in graduate student participation since 1970-71.

<table>
<thead>
<tr>
<th></th>
<th>74-75</th>
<th>73-74</th>
<th>72-73</th>
<th>71-72</th>
<th>70-71</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Total Registration</td>
<td>6,882</td>
<td>6,036</td>
<td>5,408</td>
<td>4,905</td>
<td>3,869</td>
</tr>
<tr>
<td>Increase Over Previous Year</td>
<td>846</td>
<td>628</td>
<td>503</td>
<td>1,036</td>
<td>17</td>
</tr>
<tr>
<td>Percent Increase</td>
<td>14</td>
<td>12</td>
<td>10</td>
<td>27</td>
<td>--</td>
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<tr>
<td>Five-Year Increase</td>
<td>76%</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(b) Non-Credit Registrations</td>
<td>2,653</td>
<td>2,067</td>
<td>1,443</td>
<td>1,335</td>
<td>914</td>
</tr>
<tr>
<td>Increase Over Previous Year</td>
<td>586</td>
<td>624</td>
<td>108</td>
<td>421</td>
<td>223</td>
</tr>
<tr>
<td>Percent Increase</td>
<td>28</td>
<td>43</td>
<td>8</td>
<td>46</td>
<td>32</td>
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<tr>
<td>Five-Year Increase</td>
<td>190%</td>
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<tr>
<td>(c) Analysis of Non-Credit Registrations</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Students:</td>
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<tr>
<td>1st year</td>
<td>63</td>
<td>27</td>
<td>1</td>
<td>153</td>
<td>126</td>
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<tr>
<td>2nd year</td>
<td>293</td>
<td>171</td>
<td>314</td>
<td>188</td>
<td>161</td>
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<tr>
<td>3rd year</td>
<td>341</td>
<td>438</td>
<td>229</td>
<td>200</td>
<td>208</td>
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<tr>
<td>4th year</td>
<td>415</td>
<td>329</td>
<td>270</td>
<td>229</td>
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<tr>
<td>Graduate</td>
<td>1,015</td>
<td>713</td>
<td>472</td>
<td>449</td>
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<td>Staff:</td>
<td>526</td>
<td>389</td>
<td>157</td>
<td>116</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>2,653</td>
<td>2,067</td>
<td>1,443</td>
<td>1,335</td>
<td>914</td>
</tr>
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</table>

* Advanced Squash, Air Rifle, Diving, Hockey Fundamentals, and Modern Dance, all other subjects are shown in Table II, following.
Table I (continued)

<table>
<thead>
<tr>
<th></th>
<th>74-75</th>
<th>73-74</th>
<th>72-73</th>
<th>71-72</th>
<th>70-71</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Registrations Less Non-Credit Registrations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Registration:</strong></td>
<td>6,882</td>
<td>6,036</td>
<td>5,408</td>
<td>4,905</td>
<td>3,869</td>
</tr>
<tr>
<td><strong>Non-Credit:</strong></td>
<td>-2,653</td>
<td>-2,067</td>
<td>-1,443</td>
<td>-1,335</td>
<td>-914</td>
</tr>
<tr>
<td><strong>4,229</strong></td>
<td>3,969</td>
<td>3,965</td>
<td>3,570</td>
<td>2,955</td>
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Table II: Registration Statistics for 1974-75

<table>
<thead>
<tr>
<th>Activity</th>
<th>74-75</th>
<th>73-74</th>
<th>72-73</th>
<th>71-72</th>
<th>70-71</th>
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<tbody>
<tr>
<td>Dance</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Ballet</td>
<td>173</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Folk</td>
<td>182</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Modern</td>
<td>142</td>
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<tr>
<td>Partner</td>
<td>289</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Square</td>
<td>12</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Self-Designed Fitness</td>
<td>689</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swimming</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beginning</td>
<td>399</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>84</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Synchronized</td>
<td>3</td>
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<tr>
<td>ARC Water Safety</td>
<td>77</td>
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<tr>
<td>ARC Life Saving</td>
<td>60</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Scuba</td>
<td>65</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Tennis</td>
<td>565</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Beginning</td>
<td>406</td>
<td></td>
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<tr>
<td>Intermediate</td>
<td>159</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development</td>
<td>517</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Sailing</td>
<td>322</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volleyball</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Ice Skating</td>
<td>219</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Fencing</td>
<td>203</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Archery</td>
<td>183</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Golf</td>
<td>178</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beginning</td>
<td>132</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Squash</td>
<td>158</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Independent Activities</td>
<td>599</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Period</td>
<td>599</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Included are 66 Wellesley student registrations; in addition to the above statistics, 23 M.I.T. students obtained advanced credit toward Physical Education Requirement through sports skills proficiency tests.
Intercollegiate Athletics

The deepest commitment to sports participation by M.I.T. undergraduates is made in the area of intercollegiate athletics where daily practices and scheduled competitions regularly attract close to one quarter of our young men and women.

This past year M.I.T. sponsored varsity and sub-varsity teams in 22 "open" sports -- that is, open to both sexes -- with teams selected on the basis of an individual's skills and performance. In addition, M.I.T. sponsored five varsity teams restricted to women (sailing, basketball, crew, fencing, tennis) and four intercollegiate clubs for women (gymnastics, swimming, volleyball, softball). Criteria for varsity status include established continuity of interest, daily practice, scheduling of competition, and conformity with all rules of eligibility established by the Association of Intercollegiate Athletics for Women (AIAW), including limiting competition to undergraduates. It should be noted that during this period of growth in women's sports, the four women's club teams have been provided with the same services as the five varsities except for the varsity letter awards.

Why teams restricted to women? The answer simply is this: Whereas the acceptance of women in tryouts for teams within the 22 sports does remove any discriminatory stigma from the intercollegiate program, it does not meet the Department's affirmative action goal of providing, in substance, a comparable program of competitive athletics for women. Professional leadership in women's physical education agree that very few women have the physical strength, endurance, or skill to gain meaningful experience in competition with men. Therefore, as the number of undergraduate women has increased, the Department has sponsored separate teams for women as the most effective means of providing equal opportunity for women in competitive athletics. In those sports where there are insufficient numbers of women to form a separate team, the women may try out for the open teams. Indeed, this past year, Debbie Stein, '76, was a regular member of the ski team for the third consecutive year and has been elected co-captain for next year; and Yolanta Geisler, '76, was a member of the rifle team.

Peaks and valleys in won-lost records are characteristic of team and individual performances in the 22 sports. Nevertheless, our students carry the same degree of self respect and pride in achievement into athletic competition as they do in the classroom. We try to win! The record will show we do pretty well across the board. If accept defeat we must, we strive to learn from the experience and rebound with renewed strength and objectivity in preparation for the competitions to follow. This is amateur athletics at its best.

Beginning with the late summer of 1974, outstanding performances of the past year include:

1) Heavyweight oarsmen John Everett, '76, and Gary Pientedosi, '76, were selected for the United States National Rowing Squad for the World Rowing Championship in Lucerne, Switzerland. John Everett, rowing in the #5 seat of the eight was the first M.I.T. man to win a gold medal in a world championship competition as the United States' entry came in first place. Gary Pientedosi was a spare in the same boat.

2) Lightweight oarsman Ralph Nauman, '74, rowed in the winning lightweight crew in the same competition.

3) Among fall sports, the cross-country team compiled the best dual-meet season in seven years with a 9-2 record; and two M.I.T. soccer players, Greg Hunter, '76, and Ray Marotta, '75, were selected for the Greater Boston All Star Soccer Team.
4) The fencers led the winter sports with their best season in recent years, climaxed by a second successive year of winning the Intercollegiate Fencing Association's foil team championship.

5) Two members of the pistol team won All American honors: Karl Seeler, '75, and Steve Goldstein, '76.

6) Jerome F. Dausman, '76, won the Sectional Championship in rifle.

7) Gymnast Andrew J. Rubel, '75, won the New England Division II Championship on the parallel bars.

8) Among the wrestlers, Jack D. Mosinger, '75, was the New England Champion in the 118 lb. class; and Erland Van Lidh De Jeude, '76, won All American honors with his sixth place in the NCAA Division III Championships.

9) Two members of this spring's baseball team were named to the Greater Boston All Star Team: Herb Kummer, '75, and Roy Henriksson, '76.

10) The heavyweight crews continued to distinguish themselves in national competition, the varsity finishing second only to Harvard in the Eastern Sprints. Three weeks later, the crew placed second behind Wisconsin in the national championship at Syracuse.

11) The junior varsity heavies won their national championship at Syracuse to be the first M.I.T. crew to ever win an Intercollegiate Rowing Association championship. The JVs went on to competition in the Royal Henley Regatta with results unknown at the date of this report.

12) Two members of the track team distinguished themselves in the NCAA Division III Championships: Frank Richardson, '77, placed fourth in the three-mile event, thereby winning All American honors (first six places), and Greg Hunter, '76, placed seventh in the decathlon.

Other interesting statistics on the 1974-75 year in intercollegiate athletics: The "Straight T Award" to honor those M.I.T. teams and individuals who won regional or national acclaim was presented to 34 students, including the 1974 heavyweight varsity crew and the 1974 baseball team, the most awards ever made in a single year.

Approximately 750 undergraduates competed in 540 contests in the 22 "open" sports (women's intercollegiates are listed separately in the next section of this report). Letter winner awards for 1974-75 included:

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varsity letters</td>
<td>268</td>
</tr>
<tr>
<td>Junior Varsity letters</td>
<td>106</td>
</tr>
<tr>
<td>Frosh numerals</td>
<td>150</td>
</tr>
</tbody>
</table>

Women's Intercollegiate Athletics

I submit the following from the report of Professor Mary-Lou Sayles, Director of Intercollegiate Athletics for Women: This year was marked by an increased commitment to women in sports at M.I.T. The Department has responded to the increased enrollment of women students by offering improvements and opportunities which included:
1) a much-needed and appreciated locker room at the Pierce Boathouse;

2) the January Basketball Tournament, a success that provided local and national visibility for women students at M.I.T.;

3) a training room for women and the first woman trainer who has improved greatly the quality of care for athletic injuries;

4) varsity status for three additional sports: basketball, fencing, and tennis, which received the support and encouragement of the Department, as did the newest club sports, softball and volleyball;

5) the tennis team's participation in the Eastern Tournament at Princeton was an added boost that gave the team an improved image of their ability on a regional level;

6) the commitment to an additional full-time women's coach for 1976-77 and improved coaching for 1975-76 will certainly improve the quality of the women's teams; and, finally,

7) the pool time allotted for a new club sport, synchronized swimming, clearly affirmed the Department's wish to create new opportunities for women.

Professor Betsy Schumacker, '60, a world-renowned swimmer during her undergraduate years, established an award to be given annually to the undergraduate woman who has excelled in her performance as an amateur athlete for M.I.T. The recipient for this first year was Debbie Stein, '76, a member of the M.I.T. ski team for three years and the first woman to race in the Eastern Intercollegiate Ski Association.

Women's crew received its first trophy in the form of the Carola B. Eisenberg Cup, for which there will be an annual competition among the crews of M.I.T., Princeton, and Yale. The trophy, a gift of Leon Eisenberg, M.D., in the name of our Dean for Student Affairs, was won this year by the Yale women's crew in a regatta on the Charles River. The site of the race will be rotated yearly among the three universities.

Other highlights include the following:

1) Maura Sullivan, '76, Beverly Herbert, '75, and Ingrid Klass, '76, have been elected to positions in the Varsity Club and the Athletic Association.

2) The Volleyball Club, with volunteer coach Dave Castanon, had an undefeated season of 7-0 and is well on its way to varsity status.

3) The varsity tennis team has a 6-2 record in their first spring season, and the varsity fencers were 11-1 in New England competitions.

4) The varsity basketball team had a winning season which included a win over the University of Chicago in the Invitational Basketball Tournament.

Participation statistics reveal that 137 women participated as members of the five varsity teams and four clubs, including 15 graduate students in the club sports. The undergraduate
participation represents 20 percent of the 1974-75 enrollment, which is the same general figure for the undergraduate male participation in intercollegiate sports. Letter winner awards in the five women's varsity sports were:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Varsity letters</td>
<td>40</td>
</tr>
<tr>
<td>Junior Varsity letters</td>
<td>10</td>
</tr>
<tr>
<td>Frosh numerals</td>
<td>11</td>
</tr>
</tbody>
</table>

**Intramural Athletics**

Participation statistics show an increase of slightly more than ten percent over the previous year. The increase was predominantly in the multiseasonal sports: cross-country (jogging), bowling, rifle, squash, swimming, tennis, table tennis, and volleyball.

Among innovations made during 1974-75 were the following:

1) Rules changes implemented by the Intramural Council's Executive Committee seemed to have considerable favorable impact on the entire program; there were fewer eligibility protests and fewer forfeits following the mandatory athletic card requirement for all intramural participants. It is estimated that two-thirds of the increase of 600 in card sales ($3,000) can be attributed to the rule, which carried a share of the increased expenses within the program.

2) Officiating subjects were conducted by Mike Cucchissi, '75, and Tom Stagliano, G. These subjects were offered for credit in physical education in a special arrangement with Professor Edward Crocker, Director of Physical Education; the results were a marked improvement in the quality of officiating and the added incentive of an incremental pay scale for students who qualified through the instruction.

3) Additions and changes this past year resulted in the sponsoring of chess, which attracted 19 teams in its first year; also, soccer was moved to a fall sport without any visible distraction in interest in varsity soccer.

4) "Community" leagues in baseball and soccer were offered in the spring, funded largely by an entry or user fee to cover expendable equipment which could not have been funded otherwise under the existing fiscal constraints. There was sufficient acceptance of this means of funding to warrant future use of reasonable entry fees where funding is not available otherwise.

M.I.T. women have participated in every intramural sport this past year except wrestling. Most sports managers have organized coeducational events in swimming, track, etc. A few women have requested separate women's leagues, but following discussion among members of the Women's Athletic Council, it was felt that there were insufficient numbers of interested women.
Intramural Participation Statistics for 1974-75

<table>
<thead>
<tr>
<th>Sport</th>
<th>Number of Teams</th>
<th>Total Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Badminton</td>
<td>28</td>
<td>112</td>
</tr>
<tr>
<td>Basketball</td>
<td>108</td>
<td>850</td>
</tr>
<tr>
<td>Bowling</td>
<td>89</td>
<td>275</td>
</tr>
<tr>
<td>Chess</td>
<td>19</td>
<td>120</td>
</tr>
<tr>
<td>Cross-Country</td>
<td>12</td>
<td>83</td>
</tr>
<tr>
<td>Cycling</td>
<td>5*</td>
<td>20*</td>
</tr>
<tr>
<td>Football</td>
<td>68</td>
<td>1,020</td>
</tr>
<tr>
<td>Hockey</td>
<td>56</td>
<td>560</td>
</tr>
<tr>
<td>Rifle</td>
<td>37</td>
<td>165</td>
</tr>
<tr>
<td>Sailing</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>Soccer</td>
<td>42</td>
<td>780</td>
</tr>
<tr>
<td>Softball</td>
<td>101</td>
<td>1,313</td>
</tr>
<tr>
<td>Squash</td>
<td>32</td>
<td>192</td>
</tr>
<tr>
<td>Swimming</td>
<td>16</td>
<td>150</td>
</tr>
<tr>
<td>Table Tennis</td>
<td>53</td>
<td>391</td>
</tr>
<tr>
<td>Tennis</td>
<td>67</td>
<td>335</td>
</tr>
<tr>
<td>Track</td>
<td>20*</td>
<td>175*</td>
</tr>
<tr>
<td>Volleyball</td>
<td>99</td>
<td>792</td>
</tr>
<tr>
<td>Water Polo</td>
<td>27</td>
<td>270</td>
</tr>
<tr>
<td>Wrestling</td>
<td>17</td>
<td>87</td>
</tr>
</tbody>
</table>

* 1973-74 figures - current statistics not available.

Club Athletics

Club athletics continue to attract increasing numbers of students and staff who make varying degrees of commitment to their sports and recreation interests. Devoid of eligibility rules governing intercollegiate competition in varsity athletics, the club teams are particularly popular among graduate students and others who are unable to make regular commitments to the more highly organized sports programs. At the same time, club athletics often foster regular league competition for sports less popularly supported among American colleges and universities at the varsity level. Such is the case of table tennis, where the M.I.T. club was invited to join with the Ivy League clubs in a league schedule which was climaxed in April with M.I.T. defeating Columbia for the league championship. Volleyball and graduate clubs in soccer and water polo are now playing regular schedules. The rugby club is in its twenty-sixth year of operation. In all, there were clubs in 14 sports this past year. The Department provides facilities, equipment, and subsidy within the limits of available budget. Club competition often represents amateur sport at its best.

Clubs Active in 1974-75

<table>
<thead>
<tr>
<th>Club</th>
<th>Roster</th>
<th>Club</th>
<th>Roster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Badminton</td>
<td>10</td>
<td>Karate - 3 clubs</td>
<td>75</td>
</tr>
<tr>
<td>Bicycling</td>
<td>8</td>
<td>Rugby - 3 clubs</td>
<td>38</td>
</tr>
<tr>
<td>Cricket</td>
<td>12</td>
<td>Scuba</td>
<td>35</td>
</tr>
<tr>
<td>Graduate Crew</td>
<td>10</td>
<td>Table Tennis - 2 clubs</td>
<td>12</td>
</tr>
<tr>
<td>Graduate Soccer</td>
<td>22</td>
<td>Volleyball</td>
<td>12</td>
</tr>
<tr>
<td>Ice Hockey</td>
<td>18</td>
<td>Water Polo - spring</td>
<td>14</td>
</tr>
<tr>
<td>Judo</td>
<td>42</td>
<td>White Water</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>333</td>
</tr>
</tbody>
</table>
Casual Recreation for Students and M.I.T. Community

A continuing problem of major concern to the Department is the inadequacy of existing facilities to meet the needs of the so-called casual participants who would like to indulge in their favorite sport during the popular hours for recreation at the close of the work day, but find the facilities committed to the more formally organized intercollegiate or intramural programs.

Although this problem has been thoroughly discussed, there will be no substantial relief until the completion of the new ice rink-field house and planned renovations in Rockwell Cage and the du Pont Gym. Meantime, schedules at the swimming pool and all facilities are being reviewed seasonally to increase the open hours for casual users during periods of off-peak use.

The sale of athletic cards for the past year reveals that 6,174 students participated in some phase of the athletic program. The figure represents approximately 77 percent of the registered undergraduate and graduate students.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Athletic Card Sale for 1974-75</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students</td>
<td>6,174</td>
<td></td>
</tr>
<tr>
<td>Faculty</td>
<td>379</td>
<td></td>
</tr>
<tr>
<td>Academic Staff</td>
<td>823</td>
<td></td>
</tr>
<tr>
<td>Exempt Employees</td>
<td>138</td>
<td></td>
</tr>
<tr>
<td>Bi-Weekly Employees</td>
<td>301</td>
<td></td>
</tr>
<tr>
<td>Hourly Employees</td>
<td>162</td>
<td></td>
</tr>
<tr>
<td>Alumni</td>
<td>319</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8,396</td>
<td></td>
</tr>
</tbody>
</table>

| **Sailing Cards for 1974-75** |                          |                |
| Students                    | 626                      |                |
| Faculty/Staff               | 176                      |                |
| Alumni                      | 74                       |                |
| Specials                    | 200                      |                |
| Physical Education          | 323                      |                |
| Total                       | 1,399                    |                |

Cambridge and Greater Boston Community Relations

The Department continues to extend the use of our facilities to the community at times not in conflict with our primary commitment to M.I.T. students. A special effort is made to sponsor programs involving interaction between our students and the young people of Cambridge.

During the past spring, for example, the swimming pool was used during the early hours of Saturday mornings by 70 Cambridge Boy Scouts. Members of Alpha Phi Omega service fraternity provided instruction leading to American Red Cross certification for beginner through advanced swimming levels, as well as junior life saving certification.

Continuing commitments are made, wherever possible, to supervised use of the outdoor running track and playing fields, including regular practice sessions for the Cambridge Latin and Rindge Tech squads, in close coordination with the schedule of the M.I.T. track squad. The indoor basketball courts are scheduled on a space-available basis during off-peak hours and during periods of recess when large numbers of M.I.T. students are away from Cambridge.
Finally, the Department works closely with the office of Walter Milne, Special Assistant to the President for Urban Affairs, in scheduling single events of community-wide interest.

**Major Athletic Awards for 1974-75**

The Class of 1948 Award to the Senior Athlete of the Year

Jack D. Mosinger, '75

The Admiral Edward L. Cochrane Award to the Senior who has best combined the qualities of leadership, humility, and scholarship in intercollegiate athletics

George H. Braun, '75

The Eastern College Athletic Conference Merit Medal to the Senior Scholar-Athlete of the Year

Charles L. Tucker III, '75

The Betsy Schumacker Award for excellence in athletic competition by an undergraduate woman

Deborah Stein, '76

The M.I.T. A.A.A. Pewter Bowl for outstanding contributions to women's athletics by a woman student

Beverly L. Herbert, '75

Diane M. McKnight, '75

The Straight T Award for national or regional recognition in intercollegiate athletics at M.I.T.

Peter D. Beaman, '76
John A. Cavolowsky, '76
Richard A. Chmura, '76
Jerome F. Dausman, '76
Lawrence D. David, '75
Charles E. Davies, '74
Michael W. Dziekan, '76
John G. Everett, '76
James J. Gorman, '75
Roy D. Henriksson, '76
Herbert K. Kummer, '75
Thomas J. Leise, '74
Stephen M. Maconi, '77
Vincent J. Maconi, '76
John B. Miller, '74
Jack D. Mosinger, '75
Ralph A. Nauman, Jr., '74
Michael J. Newman, '76
Gary G. Plantedosi, '76
Donald V. Proper, '76
Stephen A. Reber, '74
Kevin J. Rowland, '74
Michael A. Royal, '76
Andrew J. Rubel, '75
William S. Sayers, '74
Kenneth L. Smith, '77
Mark J. T. Smith, '78
Daniel G. Sundberg, '77
David A. Tirrell, '74
The Burton R. Anderson, Jr. Award to the Manager of the Year
Lawrence D. David, '75
Lorna J. Giles, '75

The Varsity Club Award to the Frosh Athlete of the Year
Mark J. T. Smith, '78

The Harold J. Pettegrove Award for outstanding contributions to intramural athletics
Thomas R. Stagliano, G

Staff Changes During 1974-75

William S. Morrison, Assistant Professor of Physical Education, Head Coach of Soccer and Skiing, resigned effective June 30, 1975. Walter A. Alessi was appointed Instructor in Physical Education with coaching responsibilities in Soccer and Lacrosse, effective July 1, 1975. Assistant Professor Peter A. Holland was promoted to the rank of Associate Professor, effective July 1, 1975.

ROSS H. SMITH
Provost

The Provost's section of this Annual Report reflects the activity of several laboratories, centers, and programs that have a direct relation to the Provost's office. It is the nature of such reports that they are rarely able to capture the human dimensions of much that goes on at M. I. T.

Without illusion that the few paragraphs that follow will be able to remedy these lacunae let me just mention some of the more unique entries into M. I. T.'s multifarious calendar of events.

In October, 1974, Professor Victor Weisskopf's colleagues, friends, and the public joined in a celebration for which his formal retirement furnished the pretext. There was a two-day symposium ranging from a talk by Murray Gell-Mann on "The World as Quarks, Leptons, and Bosons" to Ed Purcell's "Life at Low Reynolds Number" and Wolfgang Panofsky's "Is Negotiated Arms Control Feasible?" There was an evening of music during which Viky Weisskopf played the piano in a trio and also conducted a symphony orchestra. It was an occasion worthy of Viky the scientist, the incomparable teacher, the winner of the Cino del Duca award for humanism in science.

The Weisskopf festival was clearly unique in a year that was rich in unique events, events that brought together colleagues and alumni with members of the M. I. T. community for purposes of scholarly communication and interchange.

Elsewhere the President and the Chancellor have referred to the excitement that surrounded the discovery of the 'J' particle. Early in December, 1974, the tenth anniversary of the Cecil and Ida Green building was celebrated in a symposium on "The New Wave of Exploration in the Earth Sciences." Given the enormous progress in the earth sciences during the last decade, the symposium participants had much to discuss—from offshore petroleum to earthquake prediction—in an atmosphere of relaxed and supportive curiosity which is so characteristic of Cecil and Ida Green.

During the Independent Activities Period, a student initiative produced a remarkable two-week long happening, a series of daily seminars by faculty members, vice presidents, deans, Drs. Killian, Stratton, and Johnson as well as President Weisner and Chancellor Gray. The topic: "M. I. T. - the Institution," was a multi-splendored tale in which realities and perceptions of M. I. T. intermingled, in which generations of M. I. T. people created a record of oral and video history.

In March the Institute dedicated the Seeley G. Mudd Building, the former candy factory that was completely gutted, renovated, and rebuilt to provide modern laboratories for M. I. T.'s Center for Cancer Research, the Cell Culture Center, and the Arteriosclerosis Center. The dedication symposium represented an intersection of historical perspective, up to date science and a few statements which were a trifle controversial on science policy in the area of cancer research. The latter made the newspapers.
November, 1974, saw two memorable events: One a gathering of the seven living department heads of M.I.T.'s Mechanical Engineering out of the 11 heads the Department has had during its history. An extraordinary photograph shows the seven -- Drs. Hunsaker, Soderberg, den Hartog, Keenan, Stever, Shapiro, and Richardson -- arranged along the graceful curve of the Endicott House staircase. The Council for the Arts, on the other hand, organized a festive gathering in Walker Memorial under the heading "An Evening of the Arts at M.I.T.," which included music by M.I.T. ensembles, visual exhibits, displays of poetry and ballroom dancing. During the annual meeting of the Council, of which the evening was a part, Institute Professor Emeritus Gyorgy Kepes (also founder of M.I.T.'s Center for Advanced Visual Studies) became the first recipient of the Eugene McDermott Award "for major contributions to the arts as a means of human fulfillment."

On June 22, M.I.T. announced the establishment of the Carl Richard Soderberg Professorship in Power Engineering in honor of one of its most illustrious teachers of international fame. The dinner, during which Paul Gray announced the new chair, saw Dick and Stina Soderberg surrounded by their children and friends from two continents.

The year again brought to the campus many lecturers -- like Lewis Mumford and Alva Myrdal -- and many visitors and delegations from far away shores. The year also saw a change in the format of the Compton Lectures. This series was established in 1955 to honor the Institute's ninth president, Dr. Karl T. Compton. The series roster includes Nils Bohr, André Lwoff, and Isidor Rabi. This year's Compton Lectures were delivered for the first time by three Institute Professors. Philip Morrison lectured on "Newton among the Quasars," Robert Solow on "Facts and Theories about Natural Resources," and Institute Professor Emeritus Cyril Smith chose "Art, Technology, and History" as his topic. In the audience at all three lectures was Margaret Compton, whose influence has graced this campus for 45 years.

Elsewhere there is a record of the valued colleagues among the faculty and administration who retired at the end of the academic year. Because of the special relation which the Libraries have to the Provost's office, Natalie Nicholson's retirement and Jay Lucker's arrival from Princeton deserve to be more than just mentioned. Natalie's librarianship, charm, and humanity will be long remembered by her many friends at the Institute. In welcoming Jay Lucker, we feel fortunate to have attracted a leader in the library profession.

During the past academic year, the Urban Systems Laboratory was dissolved. It had been created, with the help of the Ford Foundation, in 1968 and had contributed--under Professor Charles L. Miller's leadership--much to mobilizing M.I.T.'s faculty and students on behalf of an urban agenda. As last year's report indicated, resources for the laboratory had become scarce as priorities seem now to be focused under different headings. Let us acknowledge here the role which this interdepartmental laboratory played in a difficult period during which dedicated faculty and staff members joined students in activities that ranged from fairly abstract modeling to urban action. Many of the programs then initiated have undergone considerable change, but the Institute's commitment to progress and equity in an urban and technological civilization remains intact. We are happy to note that Professor Miller continues to pursue his personal interests as a valued member of the Department of Civil Engineering.

Finally, the Provost had the good and valuable experience of participating together with a group of M.I.T. colleagues in a workshop held during summer, 1974, at the Technical University of Berlin on the topic of "Research and Policymaking in Relation to Problems of the Environment." This is not the occasion to review in the necessary detail the results of the cooperative venture in which M.I.T. and T.U.B. have been engaged for 11 years with the support of the Ford Foundation. As opportunities for international collaborative
programs multiply, it becomes important to analyze experiences for strengths and weaknesses in order to enhance the chances for future success.

Suffice it to say that the week-long workshop, dedicated to the memory of Professors Arthur Ippen and Rudolf Wille, was a useful exercise in which the necessity for multiple perspectives when dealing with real world problems was underlined more than once. As one proceeds from basic knowledge towards technically informed responsible social action, one becomes increasingly aware how uncertain and flickering illumination may be provided by single disciplines when we deal with problems such as the city, the environment, health, or energy.

WALTER A. ROSENBLITH
American Journal of Physics

In 1973, the Institute became the home of the American Journal of Physics, a journal "devoted to the instructional and cultural aspects of physical science," sponsored by American Association of Physics Teachers.

The editorial office of the journal moved to M.I.T. as a result of the appointment of Dr. Edwin F. Taylor, Senior Research Scientist in the Department of Physics, as Editor. Professor Anthony P. French served as Consulting Editor until beginning his sabbatical in January, 1975, when Professor Emeritus Nathaniel H. Frank assumed duties as Consulting Editor. Dr. Taylor is assisted in the editorial office by Constance Carpentiere, Administrative Editor, and Mona Nagai, Editorial Assistant.

During 1974-75, an M.I.T. student, Gary Goldberg, participated in the Undergraduate Research Opportunities Program (UROP) through his project as Filler Editor in charge of obtaining and assembling items of historical, topical, or humorous interest for use at the ends of articles. He also has begun supervising the announcements page. Another M.I.T. student, Lila Kobylak Kung, assisted with office procedures and prepared statistical reports of the Journal's operations.

The American Journal of Physics, published 12 times a year, is the foremost publication in physics education at the college and university level. Typical contributions deal with new ways of visualizing and teaching traditional physics subjects; discussions of specialized topics of particular interest or importance; new ways of organizing courses in physics; novel experiments and apparatus; the uses of computers, films, and other aids in teaching; and historical articles about fundamental developments and personalities in science.

EDWIN F. TAYLOR

Artificial Intelligence Laboratory

The Artificial Intelligence Laboratory is concerned with understanding, often through insights provided by work with computers, the principles and details underlying the acquisition and exhibition of intelligence. Its research includes work on machine vision and manipulation, understanding English text, learning, common sense reasoning, expert problem solving, human development and education, productivity technology, and computer systems.

Professor Patrick H. Winston served as director of the laboratory. Professors Marvin Minsky and Seymour Papert led general studies in artificial intelligence and cognitive theory. Professor Berthold K. P. Horn supervised the work in machine vision and in productivity technology. Professor Ira Goldstein was in charge of a new program aimed at understanding large-scale common sense knowledge systems such as those required to comprehend news articles. Professor Gerald Sussman worked in the area of learning theory and expert problem solving systems. Professor Carl Hewitt worked on programming semantics and programming languages. Professor Vaughan Pratt handled natural language studies. Dr. Hal Abelson and Professors Jeanne Bamberger and Goldstein assisted Professor Papert in work on human education and development. Richard Greenblatt and Thomas Knight worked on computer systems development research.
In 1974-75, particularly noteworthy progress was made in machine vision. Dr. David Marr developed a system which creates a symbolic "primal sketch" from vidicon or other image input. Dr. Marr's primal sketch notions, together with several feature grouping ideas, constitute a new theory of texture perception which we believe is a prerequisite to advanced applications of machine vision.

In expert problem solving, Professor Sussman and his students pushed forward with programs that understand electronics well enough to determine proper operating voltages and currents by common sense reasoning, rather than by solving the network equations. Since these programs are "smart" enough to handle even complicated integrated operational amplifier circuits, experts in the electronics field have shown considerable interest in this new, knowledge-based, common sense approach. Professor Sussman believes that these principles will transfer smoothly to other domains and become a general theory of system debugging. This work builds on the earlier thesis work of Professors Sussman and Goldstein.

In productivity technology the development of inexpensive tools for vision and manipulation studies were completed. The equipment has been used to demonstrate a variety of inspection and assembly tasks normally requiring human labor or expensive special purpose automation. A program by Professor Horn visually aligned integrated circuit chips in preparation for lead bonding, and another program by Dr. Hiroshika Inoue and David Silver assembled a radial bearing using force feedback.

In addition, the problem of knowledge representation continued to receive direct attention. The goal of this work is to devise structures suitable for accepting and facilitating the use of information such as might be associated with the visual appearance of an office or the activities ordinarily involved in something like a child's birthday party. Since a need for good purposeful description seems generally important to the creation of intelligent programs, this fundamental work on knowledge representation has wide applicability.

In the area of human development and education, the laboratory is enlarging its education experiments in cooperation with the Division for Study and Research in Education (D.S.R.E.) with a view toward providing learning environments in which students can formulate and "debug" ideas about their own problem solving procedures. A Children's Learning Laboratory, now being developed, will facilitate work with children.

Since all of these activities make extreme demands on computation resources, we have undertaken to produce an inexpensive computer capable of executing very large LISP programs. This work rests on a large collection of frontier ideas of Mr. Greenblatt and Mr. Knight.

PATRICK H. WINSTON

Cambridge Humanities Seminar

The Cambridge Humanities Seminar is a collaborative effort of universities in the Boston-Cambridge area to enrich and diversify their curriculum offerings in the humanities. The program is centered at M.I.T. and includes faculty from M.I.T., Boston University, Brandeis University, and Wellesley College, representing a variety of disciplines.

The report for 1974-75 is included in the Department of Humanities section of the School of Humanities and Social Sciences.
Center for Advanced Visual Studies (C.A.V.S.)

With the October 1, 1974, retirement of Institute Professor Emeritus Gyorgy Kepes as director of C.A.V.S., Otto Piene, German born artist and Professor of Environmental Art in the Department of Architecture, was appointed to the post. Professor Kepes was artist-in-residence at the American Academy in Rome during 1974-75.

Funding for the past year was provided by the Office of the Provost, the Council for the Arts, and the Samuel D. and May Wise Philanthropic Fund of The Jewish Community Federation of Cleveland.

The Center for Advanced Visual Studies is now committed to three different areas of work: independent artistic production, research of an artistic/technical nature, and undergraduate and preprofessional educational programs.

During the 1974-75 academic year, the Center greatly expanded its educational program at M.I.T., attracting students from many departments at the Institute and from art schools and universities in the Greater Boston area. The research at C.A.V.S. integrating art, science, and technology and experimenting with media and large-scale environmental works and events has made the Center a highly desirable learning and creative environment for young artists of advanced standing. Subjects offered at the Center in association with the Department of Architecture offer opportunities and encouragement to explore these non-traditional forms of art.

In the 1973-74 academic year, 11 students participated in special projects at the Center. With greater emphasis placed upon education in 1974-75, C.A.V.S. allocated space for a lecture/exhibition room; appointed Robert Preusser, Professor of Visual Design in the Department of Architecture, to be Director of Education; and offered six subjects per term with a total of 133 students enrolled.

The following Research Fellows of C.A.V.S. taught subjects this year at the Institute: Maryanne Amacher, Juan Navarro Baldewag, Lowry Burgess, Paul Earls, Scott Fisher, Luis Frangella, Michio Ihara, Avatar Moraes, Keiko Prince, Jon Rubin, Alejandro Sina, and Georges Singer.

The four Independent Activities Period (I.A.P.) offerings drew an additional 93 M.I.T. persons, 78 of whom were students.

The I.A.P. subjects were: Avant Garde and Experimental Film, The Bicentennial Boston Floating Dome, Change Ringing, and Multimedia Workshop: Production and Programming.

A two-week special summer Workshop on Theory, History, and Practice of Public Celebration, was sponsored by Boston 200, the city's Bicentennial organization, and the Prudential Insurance Company of America. The program attracted 26 registrants from this country and abroad, and was under the direction of Professors Piene and Preusser. Additional faculty included Dr. Earls; Professor Woodie Flowers, Department of Mechanical Engineering; Professor Walter H. G. Lewin, Department of Physics and Center for Space Research; Elizabeth Goldring, Director of Exhibitions at Boston's Children's Museum; and Harron Ellenson, Administrator for Festival America of Boston 200.
In connection with this special program, on July 4, a 750-foot inflated tri-tubular polyethylene balloon flying three 20' x 30' flags (American, Boston 200, and Rainbow) will be launched from the Prudential Plaza to the second-to-top floor of the Prudential Insurance Company building in Boston as a Bicentennial event and as a culmination to the summer session celebrations workshop.

Another special program, Midsummer Daydreams: Problems in Color, Form, and Sound is being offered through the Department of Architecture with artist-Fellows Burgess, Earls, and Ihara as instructors.

Because of the apparent success of C.A.V.S.'s environmental art subjects and the enthusiasm generated by students and teachers alike, the Center will continue to consider its involvement in education at M.I.T. a major enterprise.

Unsolicited applications for a graduate program at C.A.V.S. from students across the country and from special students who have been attending Center subjects, has resulted in the formation of an Education Group at C.A.V.S. this past spring. The present purpose of this group is to investigate and to propose the incorporation of an interdisciplinary Master of Science degree in Art as an M.I.T. course of study. This preprofessional training program would be the first of its kind claiming and requiring interdisciplinary skills and activities among art, science, engineering, and humanities. It is the Education Group's conviction that M.I.T. is the optimal place for such a program to emerge. The Group also will evaluate the possibility of offering a Master of Architecture degree in Advanced Studies for environmental creative research and artistic work.

Since the fall, 1974, conversion of studio space to a lecture/exhibition room, C.A.V.S. has openly invited and encouraged the M.I.T. community and the public to view and participate in some of its activities. Exhibitions held at the Center between December and June included: "Reflections," Luis Frangella and Scott Fisher; "Steel Sculptures," Michio Ihara; "Recent Works," C.A.V.S. Fellows; "Kinetic and Mural Sculptures," Robin Parkinson; "Interior," Juan Navarro Baldewag; and sculpture, student works.


Presentations by visiting artists also were held in the lecture/exhibition room of C.A.V.S. during 1974-75. Of particular interest and popularity was a concert of rarely performed compositions by Stockhausen and Kagel, and poetry by Marcel Duchamp and Kurt Schwitters with flutist Eberhard Blum, a member of the Center of the Creative and Performing Arts, State University of New York at Buffalo.

Last fall marked the return of the M.I.T. Multiple Interaction Team Exhibition. Supported by the National Endowment for the Arts, this exhibition-event of C.A.V.S. Fellows' works traveled over a two-year period to eight museums: Museum of Science and Industry, Chicago; The Exploratorium, San Francisco; Cincinnati Contemporary Arts Center, Cincinnati; New Orleans Museum of Art, New Orleans; The Science Museum of the Franklin Institute, Philadelphia; Museum of Fine Arts, St. Petersburg; Hall of Science, New York City; and California Museum of Science and Industry, Los Angeles. In November, 1974, several of the pieces from this exhibition were displayed in an M.I.T. Lobby 7 show, "Asterisk."
Also in November, 12 of the Center's Fellows were among the 300 international artists participating in the Eleventh Annual Avant Garde Festival of New York organized by Charlotte Moorman and held in Shea Stadium.

The Institute of Contemporary Art in Boston invited the Fellows to have an exhibition in March and April, 1975. The show, "Boston Celebrations: Part I," sponsored in part by the Charrette Corporation, opened on March 18. With the Bicentennial in mind, the Center's artists displayed models, drawings, and conceptual pieces for temporary visual celebrations on specific Boston sites.

"Boston Celebrations: Part II," which will be co-sponsored by the Massachusetts Council on the Arts and the National Endowment for the Arts, is scheduled for February/March, 1976, at the Institute of Contemporary Art. The purpose of the exhibition will be to prepare and present projects designed to improve specific sites by environmental and sculptural means. It is hoped that one or two of the projects will be executed in the City of Boston.

In April, 1975, Otto Piene and several of the Center's Fellows participated in an evocative and controversial Lobby 7 show entitled, "Food." Some works were "The Popsicles" by Keiko Prince, "Product vs. Product" by Luis Frangella, "Jaws" by Alejandro Sina, and "The Big Apple" by Otto Piene, Paul Earls, Bart Johnson, Robert Preusser, and Georges Singer. The show covered food as image, edible art, sculpture, performance, poetry, politics, and science.

The Alumni Association at M.I.T. approached C.A.V.S. to present a "visual happening" for its June 6 Alumni Day. With sound provided by Paul Earls and inflatables by Otto Piene, the New England Dinosaur Dance Company collaborated to realize "Three Period Pieces," a performance of dancers harnessed to helium-inflated mylar balloons.

During the past year the Center has been negotiating short-term fellowship exchange programs with the Carpenter Center for the Visual Arts at Harvard University and with the Center of the Creative and Performing Arts, State University of New York at Buffalo. A similar arrangement is being negotiated with the Visual Arts Program at Princeton University. Through Lowry Burgess, C.A.V.S. Fellow and Professor of Visual Fundamentals at the Massachusetts College of Art, the Center also has arranged collaboration with the Massachusetts College of Art and the School of Architecture and Planning in the form of a 1975-76 joint subject offering, Advanced Visual Design: Glass, Gas, and Electricity, which will use facilities and staff from both institutions. A one-to-one student exchange program between the College and the School will be implemented along with the subject offering.

The fellowship program at the Center for Advanced Visual Studies has been expanding over the past year to embrace five primary fields of interest: environmental art and design; experimental media work; art and technology; celebrations; and education in new art forms. During 1974-75, the Center hosted 18 artists. Of these, 14 were Research Fellows, two were Research Affiliates, and there was one guest, and one artist on the Sponsored Research Staff. Beyond their educational and collaborative commitments, these artists also were engaged in individual projects, installations, and exhibitions, both inside and outside of the M.I.T. community.

Professor Piene did much of his outside work in his native Germany, including a major exhibition of fire gouaches and fire paintings at the Galerie Heimeschoff in Essen, Germany and several 50-minute television specials about his work. These were entitled "From Zero to the Rainbow" and "Light Trail in the House of the Sun," and were aired several times last spring in Germany, both on prime-time TV and as part of educational broadcasts.

Carl Nesjar, a Norwegian sculptor and photographer who was a guest at the Center last
Center for Advanced Visual Studies

year, gained much public recognition for the installation of two large-scale Picasso sculp-
tures, one at M.I.T.'s Hermann Building plaza, and another, larger one, outside Chicago
in Rolling Meadows, Illinois. Mr. Nesjar also completed work on his own design of an
"ice fountain" for a French Alpine resort. He also exhibited his photographs in the Hayden
Gallery Corridor at M.I.T.

Other installations by Center Fellows included Michio Ihara's stainless steel sculpture for
the Fitchburg Public Library; a Bicentennial event for City Hall Plaza in Boston entitled
"Cityring" which involved a 6 1/2 minute polytonal work for massed bands and handbells
by Paul Earls and a large spiral canopy for the plaza by Lowry Burgess; sound environments
at the Walker Arts Center, Minneapolis, Minnesota by Luis Frangella and Maryanne Amacher.
Ms. Amacher also composed and performed "Events 133 and 134" for the Merce Cunningham
Dance Company in New York. Friedrich St. Florian exhibited his architectural studies and
projects at the Museum of Modern Art in New York and at the University of Utah's Graduate
School of Architecture. Douglas Davis, video artist and Art Editor of Newsweek, had one-
man exhibitions at the Everson Museum of Art in Syracuse, New York and at the Museo de
Arte Contemporaneo in Caracas, Venezuela. Mr. Davis also aired his videotapes on the
Austrian Television Network and WNET-TV, Channel 13, in New York. Paul Earls pre-
sented his musical performances at Massachusetts College of Art's "Annex Players in
Residence," and Ernst Caramelle his "Video Ping Pong" at the Hayden Gallery, M.I.T.

Several Fellows at C.A.V.S. have received grants during the past year that supported their
ongoing projects. Avatar Moraes came from Brazil under the auspices of a Guggenheim
Fellowship; Georges Singer, a graphic designer and multi-media artist from Montreal,
with a Canada Council grant. Alejandro Sina received an extension of his Fulbright scholar-
ship to continue his work with kinetic sculpture. Gyorgy Kepes, former Director of the
Center, received M.I.T.'s Eugene McDermott Award of the Council for the Arts.

In addition to these individual awards, the Center gained public recognition through various
publications. Among these was an article about the Center in the January issue of Art
International by Jonathan Benthall, English art historian and critic, and an interview with
Professor Kepes in Stewart Kranz' book, Science and Technology in the Arts. Douglas
Davis' video work was reviewed in the December issue of Arts Magazine; Carl Nesjar's
work in the March issue of The Art Gallery Magazine; and Lowry Burgess wrote an article
about his own work entitled "Waiting-for-Light-Planes" for the international journal
Leonardo.

OTTO PIENE

Center for Cancer Research

The Center for Cancer Research began operation on September 1, 1973, under a Center
Grant from the National Cancer Institute. The Center moved into the Seeley G. Mudd
Building during 1974, and by June, 1975, had grown to employ 98 workers, including 11
faculty, two M.D.s, and 25 Ph.D. associates. Its research expenditures in the 1974-75
academic year were more than $1.5 million which was provided by research grants and
contracts and by various M.I.T. sources.

All current work in the Center is directly related to experimental cancer research. It
includes, in addition to work on animals and on isolated cells in cultures, research of a
fundamental and diagnostic nature on material from hospital patients, particularly on leukemia.
Research is organized in three groups. The virology group is concerned with two types of cancer viruses: the RNA tumor viruses including those responsible for sarcomas and leukemias in mice, chickens, and probably also humans; and the adenoviruses, responsible for a variety of animal cancers.

The cellular and developmental biology group studies the process of mutation, which underlies the appearance of cancers; the changes in cellular membrane proteins that accompany the cancerous transformation and may be responsible for malignancy, but also for body defenses against cancers cells; and the abnormal expression of various genes in cancer cells.

The immunology group concentrates on studies of specific antigens on cancer cells that can lead to cell destruction in the organisms, on the structure of the antibody molecules involved in the rejection, and on the development of the immunological response during animal development.

The personnel of the Center for Cancer Research have received a number of recognitions in the two years since the inception of the Center. Professor David Baltimore received the Molecular Biology Award from the National Academy of Sciences in 1974, and was elected to the Academy in that year, joining two other members of the Center, Professors Herman N. Eisen and Salvador E. Luria.

The Center's faculty carries out educational functions in the cancer field, including supervision of 16 Ph.D. theses in cancer research; the teaching of various subjects on cancer cells, and the provision of UROP and other research opportunities to undergraduate M.I.T. students.

SALVADOR E. LURIA

Center for International Studies

The past year saw continued growth in the Center for International Studies of its program in international policy questions related to technology and technological change. Along with increased substantive emphasis on technology-related issues came an expanded participation in the Center by faculty and students from the science and engineering departments of M.I.T. in addition to those from the social sciences.

Substantial emphasis has been placed on developing a program of research and policy studies on issues that, while subject primarily to control or influence by national policies, affect other nations and the global system in complex ways. The webs of interdependence that ramify individual national decisions into international or transnational concerns are increasingly evident. Our program has focused on three aspects: 1) the general nature of global interdependence; 2) the nature and problems of international efforts to monitor and regulate these global interactions; and 3) the growing recognition that advanced industrial societies face many common or similar problems and may be able to learn from each other's experience.

Professors Hayward Alker, Jr., Lincoln Bloomfield, and Nazli Choucri, all of the Department of Political Science, completed a study sponsored by the U.S. Department of State which analyzed current academic literature and policy writings on global interdependence, formulated policy implications that flowed from that analysis, and illustrated with a case study of international energy interdependence the ways in which global interdependence
could be examined to produce policy-relevant results. The three authors wrote a joint report on this topic, and are preparing further individual publications.

Work will begin this summer on issues relating to international environmental monitoring. The fact that activities affecting local environment within the borders of one country impact beyond national boundaries has long been recognized. The rapid spread of industrial technology and increased scientific understanding of the complexities of the environment have heightened concern over damaging and potentially catastrophic changes that human activity may be creating. The special focus of the Center's work here will be on the social, economic, and political factors that affect the creation and operation of international programs to monitor environmental changes and the utilization of the information such systems generate. Initially the problems of the ozone layer depletion and the changes in the earth's albedo will be taken as illustrative cases. The Center will work in close collaboration with scientific studies of these problems under way at M.I.T. and elsewhere. Professor Eugene B. Skolnikoff, Director of the Center for International Studies, and Professor George W. Rathjens, of the Department of Political Science, will direct this effort, and Howard Margolis, Research Associate at the Center, will be a major contributor. Initial funding has been supplied by the Rockefeller Foundation.

The future nuclear energy industry is the subject of another major study being conducted by Professors Joel Yellin of the School of Humanities and Social Science, Henry Jacoby of the Alfred P. Sloan School of Management, and Paul Joskow of the Department of Economics, with Ford Foundation support. This is an instance in which the consequences of global interdependence in energy (principally oil) have affected profoundly the economics of the nuclear energy industry and spurred accelerated growth. The projected scale of the industry within a decade raises a host of unprecedented regulatory problems, both national and international. This is an area in which industrial growth commitments are being made in the face of significant economic, technological, and political uncertainties that are, by and large, beyond the capacity of any single nation to mold.

Communication, within and among nations, has been part of the Center's program from its founding. A joint research program currently being conducted with the Center for Policy Alternatives is emphasizing the impact of new communications technology both on national investment and regulatory decisions and on international effects. Technology has greatly increased the political and economic development benefits that can be realized by national communications systems; at the same time technology has raised the apprehension that national communications may be too easily dominated by repressive local forces or intruded upon by hostile external forces. The multiplicity of issues of this nature are being studied in connection with such specific communications areas as cable television, satellite broadcasting, and data communication systems. Professor Ithiel Pool, of the Department of Political Science, directs the Center's part of this program, with support from the Markle Foundation.

Advanced industrial societies have evinced a common phenomenon--the persistence of traditional economic sectors alongside modern sectors. This phenomenon was commonly observed by those who studied developing economies. The Center's research, which is supported by the Ford Foundation, is aimed at trying to understand what the economic, political, and social functions are of this economic dualism in the advanced industrial societies of Europe and North America. Professors Suzanne Berger, of the Department of Political Science, Lisa Peattie and Martin Rein, both of the Department of Urban Studies and Planning, and Michael Piore, of the Department of Economics, are conducting the research.
Other current research topics relating to global interdependence and problems common to advanced industrial societies are: technology assessments made in the United States in the early days of the development of telephone communications, which are being studied by Professor Ted R. I. Greenwood, of the Department of Political Science; the international economic order, being studied by Professor Lester Thurow, of the Department of Economics; foreign policy planning in the face of global interdependence and internal dissensus, studied by Professor Bloomfield; industrial conflict patterns in advanced industrial societies, being studied by Professor Douglas Hibbs, of the Department of Political Science; the manner in which nations have historically responded to constraints on access to resources, by Professor Choucri; decision making in regulatory agencies, by Dr. Lawrence McGray, Research Associate of the Center; and models of urban economies, by Professor Yellin. These studies are supported by the National Science Foundation/Research Applied to National Needs (NSF/RANN), NSF, the Kettering Foundation, and the Ford Foundation.

For several years, the Center has been actively involved, in collaboration with the Department of Nutrition and Food Science, in the development of a program of teaching, research, and advisory services on nutrition planning. The program, directed by Professor F. James Levinson, of the Department of Nutrition and Food Science, has attracted M.I.T. graduate students in Nutrition, Economics, and Political Science who can build upon the foundation of their separate disciplines with an exposure to the nutritional, economic, social, and political considerations that go into developing national nutrition plans. Special year-long and shorter-term training subjects have been developed for persons in national governments and international and nongovernmental agencies concerned with nutrition planning. Research is being conducted on a variety of topics, including the impact of U.S. agricultural and food policies on the nutritional programs of developing countries.

The governments of several countries have asked the program for advice on the preparation of national plans to improve nutrition in their countries. These governments have included those of Brazil, Indonesia, Chile, Guatemala, Panama, and Nigeria. A major advisory effort, of several years' duration, is getting under way in Pakistan. Core funding for the program was provided by the Rockefeller Foundation and the Agency for International Development (AID), and support for specific projects has been obtained from NSF and AID. Overall planning for the program is the responsibility of an Advisory Committee composed of Professors Skolnikoff, Nevin Scrimshaw, Head of the Department of Nutrition and Food Science; Myron Weiner, Head of the Department of Political Science; and Richard Eckaus, of the Department of Economics, as well as Professor Levinson.

The political and developmental effects of migration have been subjects of research at the Center for many years. These efforts have been brought together into a coordinated program of studies. Rural to urban migration in Mexico is being studied by Professor Wayne Cornelius, of the Department of Political Science, from the perspective of the communities from which migrants come and the effectiveness of government efforts to improve economic and social conditions in rural areas in order to reduce incentives to migrate. In India, Professor Weiner is studying the impact of government measures at the municipal, state, and national levels designed to regulate or restrict migration within the country. A comparative study of the determinants of migration in Indonesia and Kenya has been initiated by Professor John Harris, of the Departments of Economics and Urban Studies and Planning, to explore the effects of migration variables on development plans. Attitude changes among migrant workers will be studied in Austria by Dr. Rosemarie Rogers, Research Associate at the Center. Research on migration issues is supported by the Smithsonian Institution, the Ford and Rockefeller foundations, and the National Institute for Child Health and Human Development, which, in addition to supporting specific projects, is providing core program facilities to coordinate ongoing research and develop and expand the program.
Work on arms control and defense problems is well established at the Center. Currently, major attention is focused on issues relating to nuclear proliferation, especially as affected by new technological developments and the growing importance of nuclear energy generation. Other current research in this field concerns the attitude of small and middle powers toward U.S.-U.S.S.R. arms control arrangements; conventional arms trade; decision-making concerning SALT; arms race models; the role of the Senate in arms control; U.S.-Soviet strategic relationships; tactical nuclear weapons in Europe; and the significance of new military technologies. In addition, the Center sponsors, in conjunction with the Program for Science and International Affairs at Harvard, a seminar series for the Cambridge community on current arms control and defense issues. The Ford Foundation has provided the major proportion of support for current arms control studies, and additional support has been provided by the Rockefeller Foundation, the Sloan Foundation, the Itel Corporation, and the Aspen Institute. The program is directed by Professor Jack Ruina, of the Department of Electrical Engineering and Computer Science, with a Steering Committee including Professors Skolnikoff, Rathjens, Greenwood, John Deutch of the Department of Chemistry, Kent Hansen of the Department of Nuclear Engineering, and Amelia Leiss, Assistant Director, Center for International Studies.

International business activities constitute important elements of the international economic and investment system. In collaboration with the Alfred P. Sloan School of Management, the Center is conducting a series of studies on international business under the direction of Professors Pool, Everett Hagen, Professor Emeritus of Economics and Political Science, and Richard Robinson of the Sloan School. Work on this project has concentrated in four areas: the international monetary system; the climate for international business; the employment effects of international direct investment and trade adjustment regulations; and international investment decisions. Specific current research within these fields includes work on the effects of flexible exchange rates; Peru's experience with worker participation in management; the impact of the Andean Pact requirement for "entry contracts" as a condition for foreign investments; the economic factors affecting licensed production of high technology arms; direct foreign investment in the U.S. electronics industry and the Brazilian automobile industry; evaluation of U.S. adjustment assistance programs to cushion the impact of imports on employment; and an international comparison of rates of return on capital. Support of the project has been obtained from the U.S. Department of Labor, the Tinker Foundation, the Ford Foundation, and several corporations (John Deere, Caterpillar Tractor, Pfizer, Morgan Guarantee Trust, IBM, IBM World Trade, Merck, Unilever, Universal Oil, Nestle, and St. Gobain).

Center research also has continued in fields that have long been important foci of our research, and new opportunities continue to arise for work in areas that, while not directly related to major research concentration, nonetheless offer important opportunities. The following topics are currently being studied: nonruling parties in Western Europe by Professor Donald Blackmer, Associate Dean, School of Humanities and Social Science; ethnicity and group identity by Professor Harold Isaacs, of the Department of Political Science; communication among Indonesian elites by Professor Lucian Pye, of the Department of Political Science; the use of social science research in policy making by Professor Berger; computer applications for social science research by Stuart McIntosh, Research Associate, Center for International Studies; Congressional oversight of the Central Intelligence Agency by Norman Sandler and Michael McNamee, students in the Department of Political Science; and communist and radical movements by Professor William Griffith, of the Department of Political Science. Support for this research comes from the Ford Foundation, American Council of Learned Societies, the New World Foundation, the U.S. Information Agency, the Organization for Economic Cooperation and Development, NSF, the Cos Cob Foundation, and the Earhart Foundation.
The Center also sponsors seminars on topics related to its research for the M.I.T. community, and publishes a monograph series of research reports. In addition to individual seminars on a wide range of international issues, a series of special seminars have been held on communications policy, tactical nuclear weapons in Europe, and new military technologies. A seminar on general arms control problems was held in conjunction with the Program for Science and International Affairs at Harvard University.

EUGENE B. SKOLNIKOFF

Cell Culture Center

The Cell Culture Center at M.I.T. has been established and funded by the Human Cell Biology Program of the National Science Foundation. It is intended to serve as a facility and resource for cell biologists primarily, but not exclusively, in the northeastern part of the United States; applications from other parts of the country, however, are welcomed.

The Center is headed by Professor Phillip W. Robbins of M.I.T. and Dr. Richard L. Davidson from the Harvard Medical School and the Massachusetts General Hospital; it operates under the direction of Don Giard. The mission of the Center is to produce cells and viruses on a large scale in order to allow scientists to conduct novel and important experiments in basic cell biology that could not be accomplished with the materials and resources available in the investigator's own laboratory. Special consideration is given to young investigators with limited resources. The Center is working directly with individual scientists on basic research problems and, in addition, is conducting an active program in the development of new techniques for large scale cell and virus production.

Since the Center began operation in November, 1974, it has received 45 applications, of which 25 have been approved. Applications are reviewed by an Operating Committee composed of scientists in the Boston area, and the primary criterion for approval is the scientific merit of the proposed projects. To date ten of these projects have been completed. Examples of these are: 1) production of 100 mg of Sindbis virus propagated in 200 roller bottles of secondary chick embryo cells for use in X-ray structural studies; 2) Production of 750 roller bottles of SV-40-transformed Balb 3T3 cells which are being used for purification and characterization of T-antigen; and 3) growth of 300 liters of mouse leukemia cells in suspension for studies relating to the isolation and structural analysis of a specific lysine transfer RNA implicated in the control of cell division.

Currently the Center is operating at approximately 50 percent of its total capacity. It is expected that production will be increased to 75-100 percent of its full potential during 1976.

PHILLIPS WESLEY ROBBINS

Committee on the Visual Arts (C.V.A.)

The Committee on the Visual Arts is a faculty committee established in 1966 to act as a coordinating body for the varied and growing non-academic interest and activities in the visual arts at M.I.T., to study the problems of the visual environment of the Institute, and to make recommendations in this area to the President.
Committee on the Visual Arts

The Program of the Committee on the Visual Arts is guided by the following responsibilities:

1) To acquire works of art in all mediums for the M.I.T. Permanent Collection that will provide educational as well as aesthetic benefit to the M.I.T. community and the greater Boston public as well.

2) To initiate non-curricular activities in the visual arts--lectures, colloquia, exhibitions, etc.--ranging from small student discussions to major events open to the M.I.T. community and the general public.

3) To initiate exhibitions in Hayden Gallery, Hayden Corridor Galleries, and adjoining outdoor court, and other designated areas to complement the educational programs, bringing the entire M.I.T. community into close touch with the artistic events of our time.

4) To oversee the Institute art collection and promote its use to enhance the visual environment of the Institute.

5) To oversee the Catherine N. Stratton Collection of Original Graphics and promote its use by students to enhance their living environments.

6) To cooperate with the Planning Office in its effort to improve the visual environment of the Institute.

7) In general, to act as a coordinator for the interest in the visual arts at M.I.T. for their full realization and greatest benefit to the community.

The faculty membership of the C.V.A. includes: Wayne Andersen, Chairman (Professor of Art History, Theory and Criticism), John Buttrick (Director of Music and Associate Professor of Music), Boris Magasanik (Professor, Head of Department of Biology), Bruce Mazlish (Professor, Humanities), Judith Wechsler (Assistant Professor, Art History, Theory and Criticism), Whitney Chadwick (Assistant Professor, Art History, Theory and Criticism), David Hoult (Assistant Professor, Mechanical Engineering), Jerome Rothenberg (Professor, Economics and Urban Studies), Richard Eckaus (Professor, Economics) Albert Gurney (Professor, Literature).

Ex-officio members are: Walter A. Rosenblith (Provost), Bruce K. MacDonald (Director of Exhibitions), and Peter M. Spackman (Director, Council for the Arts at M.I.T.).

Committee Action

Over the past year, C.V.A. has continued to execute the various responsibilities stipulated in the guidelines. The environmental art program is well under way with the installation of a sculpture by Pablo Picasso in front of the Hermann Building and large-scale works by Henry Moore, Tony Smith, Louise Nevelson, Jacques Lipchitz, and possibly Boston artist Christopher Sproat due for siting during the next academic year.

In addition to major sculpture acquisitions mainly for outdoor sites, the Committee has continued to purchase art for interior public and office spaces through the M.I.T. one-percent-
for-art program and support of contemporary art in public spaces has provided a model for Boston and the increasing number of other cities interested in revitalizing the outdoor environment.

**Picasso Sculpture sited in front of the Hermann Building**

On May 30, 1975, *Figure découpée*, a monumental sculpture designed by Pablo Picasso and executed by Carl Nesjar was sited in front of the Hermann Building at the east end of campus. The piece was brought to C.V.A.'s attention by President Jerome Wiesner in 1973, and acquired by M.I.T. through the generosity of an anonymous friend of the Institute.

The sculpture is constructed of white reinforced pre-packed concrete and engraved by sandblasting to reveal a contrasting dark stone aggregate interior. It is among the last Picasso-authorized designs to be cast before his death in 1973. *Figure découpée* is one of a frontal series of oil on wood models conceived by Picasso in 1958. Playfully combining imagery of both fish and bird, Picasso synthesizes a multiplicity of angles on one plane. The artistic solution to presenting different points of view simultaneously which Picasso explored in his Cubist works as early as 1908 is given inventive variance in the M.I.T. piece. An installation plan determined by the C.V.A. was carried out with Physical Plant, and special meetings were held to investigate soil and utility placement. The Planning Office was consulted on landscaping.

The C.V.A. proposed a low-cost landscape design to supplement the existing trees. The sculpture rests on the ground in an irregularly shaped bed of ivy and is flanked by a screen of six newly planted Austrian Pines set in a curvilinear configuration to offset the symmetry imposed by the central placement of the piece itself. A plan for illumination was also determined by the C.V.A. as an important part of the total installation.

The C.V.A. worked closely throughout the year with Carl Nesjar, a former Center for Advanced Visual Studies Fellow who has exclusive authorization to carry out Picasso's designs in concrete. Nesjar adapted the Betogrev cast concrete technique for this purpose and has cast seventeen Picasso designs in the last 19 years. Nesjar executed *Figure découpée* in 1963, and supervised the installation at M.I.T.

**Tony Smith for West Campus Housing**

A large-scale sculpture by the noted American artist Tony Smith will be installed sometime next fall in a grassy area at the west end of Amherst Alley entering Westgate Housing. Tony Smith is one of the first proponents of the Primary Structures or "minimal" sculpture movement which got under way by the mid-sixties. A former architect, Smith turned to sculpture in 1960 with monumental cubic constructions of steel plate. From the basic tetrahedral module, Smith generates asymmetrical forms of considerable complexity. Although derived from geometrical form, Smith's sculpture, unlike other non-connotative minimal work, has compelling primal atavistic associations. The M.I.T. piece, approximately 18' x 12' and painted fire engine red, was designed in 1962 and is related to the modified portal sculptures like his famous *Marriage* (1961-65) and *Cigarette* (1961). Smith believes his work is best presented outdoors surrounded by trees and shrubs.

The piece will be acquired through the one-percent-for-art program associated with the new West Campus Housing.

**Louise Nevelson for Chemical Engineering Facility**

On May 22, Louise Nevelson presented to the C.V.A. her model for a sculpture designed for a space outside the Chemical Engineering Facility. Due for completion early next year,
the building designed by I. M. Pei and Associates falls under the campus one-percent-for-art stipulation. Preliminary discussions had taken place between the architect, Nevelson, and the Chairman of the C.V.A., and last fall Nevelson visited M.I.T. to evaluate possible sites related to the building. The maquette was overwhelmingly approved by the C.V.A. with the consent of the Head of the Chemical Engineering building, and fabrication plans are now in process.

Composed of sheet metal scraps assuming vaguely botanical shapes and motifs that are heirs to the found wood objects Nevelson used in earlier works, the sculpture captures in steel the nostalgic romanticism she has abandoned in many of her recent public commissions. It is Nevelson's body of work of the mid-fifties, culminating in the great environmental Dawn's Wedding Feast of 1959 at the Museum of Modern Art, that firmly established her reputation as one of America's greatest sculptors. The M.I.T. piece, basically an open work with passage wide enough to walk through, will be aligned with the entrance to the Chemical Engineering Building. Nevelson has always been interested in the total environment, and designing works for public spaces takes into account her holistic sensibility.

The work has been carefully conceived for siting at the northeast edge of the grassy area between East Campus Houses. It will be visible from two major M.I.T. community pedestrian avenues across campus as well as from Memorial Drive and the Ames Street complex area of E17, 18 and 19. The Nevelson, like the Tony Smith, will come to M.I.T. at only the cost of fabrication and installation.

Cancer Research Building

A large selection of paintings and works on paper were acquired for and installed in the Seeley G. Mudd Building under the auspices of the C.V.A. The Chairman selected and the C.V.A. approved major works by leading American painters, some from the Boston area; important original graphics and drawings, and a group of original posters.

Included in the selection are major paintings by Natvar Bhavsar, who works with dry powder pigment on canvas; Ed Ruda, whose recent experiments with stained canvas reflect the new landscape sensibility; Kestutis Zapkus, a young New York artist whose work is concerned with a new interest in texture which has arisen from unprimed stained canvas explorations; and Natalie Alper, Nan Argyros, Susan Shatter, and Joel Janowitz, important Boston artists. A group of posters by major American artists was offered as a way to acquaint people with better works of art while at the same time satisfying the requirement of distributing low-cost artwork through numerous offices and hall spaces that cannot accommodate major works.

Short-term loan of monumental work by Max Ernst

The C.V.A., through the efforts of the Council for the Arts and Dr. Wiesner, has arranged for a short-term loan of a monumental sculpture by Max Ernst, the noted Surrealist artist. Offered to M.I.T. by Mrs. Dominique de Menil, of Dallas, a member of the M.I.T. Council for the Arts, the work, entitled Capricorn, was most recently shown at the Guggenheim Museum's Max Ernst retrospective this spring.

Capricorn, cast in bronze in 1964, was first executed in reinforced concrete in Arizona. As in some of Lipchitz' work, there is a relationship to African sculpture, but in Ernst's sculpture the figures convey a cryptic but potent iconography related to Surrealist thought. Arrangements are now being made to site the work in the lobby of the Materials Science and Engineering Center (Bush Building), where it will remain until its return to Texas in January, 1976. The piece is currently on view in Hayden Gallery.
Long-term loan of Lipchitz sculptures

The extended loan of seven bronze sculptures by the renowned Twentieth Century artist Jacques Lipchitz was enthusiastically endorsed by the C.V.A. Six were offered by the artist's widow Yulla and their daughter Lolya, and a seventh by Mr. and Mrs. Ralph Pomerance. Mrs. Pomerance is a member of the M.I.T. Council for the Arts.

The Lipchitz works represent examples of his stylistic changes over a period of more than three decades. Bather (1923-25) still contains elements of the Cubist idiom of his earlier sculptures. The well-known Figure (1926-30) shows the influence of African sculpture, which the artist admired and collected. Joie de Vivre (1927) demonstrates the lyricism that was to flow through his art at various periods. Lipchitz' affinity for Biblical inspiration is interpreted in Song of Songs (1945-48), the piece from the Pomerance collection, and Hagar in the Desert (1957). Sacrifice III (1949-57) documents Lipchitz' preoccupation with the motif of ritualistic sacrifice, and Birth of the Muses (1944-50) is based on one of the Pegasus legends of antiquity.

Arrangements were made to present the works in the recent Loans and Acquisitions exhibition installed in the Hayden Gallery through midsummer.

Lipchitz sculpture plaza

A subcommittee with representatives from the Planning Office, the Office of Exhibitions, the Humanities Library, the M.I.T. Council for the Arts, and Physical Plant has been organized by the C.V.A. to work with landscape architect Diane McGuire to convert the Hayden Courtyard into a Lipchitz sculpture plaza where the works will be installed for the duration of their stay at M.I.T. The refurbishing plan calls for integration of plant materials, seating, and sculpture base designs with sculpture arrangement.

Christopher Sproat commissioned to execute a neon work for the Electrical Engineering Building

The C.V.A. approved a proposal by Boston artist Christopher Sproat to run a line of blue neon tubing following the staircase configuration the length of the stairwell on the Vassar Street side of the Electrical Engineering building. There has been a history of deliberation over the artistic possibilities raised by this area of the facility. The architectural solution of using an orange color to articulate this interesting feature of the design has been further defined by Sproat. His plan calls for a rejection of the use of color in favor of light. An incandescent glow, only partially visible in daylight, will slowly emerge as dusk appears, offering a soft contrast to the rigid geometry of the building.

A meeting was held with representatives of the Electrical Engineering facility to explore the work's technological aspects and installation procedure. At present the commission has not been approved by the client.

Artwork sited in Electrical Engineering Building

The remaining Electrical Engineering art allowance funds were spent on major works by seven important artists, most of whom are currently working in New York, and one drawing and one montage by Friedrich St. Florian, a Fellow at the Center for Advanced Visual Studies whose shows have included those at M.I.T. and the Museum of Modern Art, New York.

A preliminary meeting was held with representatives of the C.V.A. and an art committee from Electrical Engineering attending. A general distribution program was set up and spaces were analyzed for appropriateness and security. A selection meeting was then held with building users participating and works were sited and hung by the C.V.A. staff.
Proposals to the C.V.A.

Among the many proposals brought before the C.V.A. during the 1974-75 academic year were: the gift by I. Austin Kelly of Nineteenth Century etchings by Montague Dawson; the purchase of a sculpture and drawing by C.A.V.S. Fellow Friedrich St. Florian for the Electrical Engineering building; the donation by Charles E. Reed of the remainder of his Escher print collection; the availability of an important sculpture entitled 3 Elements by Primary Structuralist Ronald Bladen as the first serial sculpture to be acquired by M.I.T.; a sculpture by Bernard Kirschenbaum for Electrical Engineering; a sculpture loan by the artist Douglas Abdell.

Office of Exhibitions Activities

The Office of Exhibitions, operating under the aegis of the Committee on the Visual Arts, is charged with the exhibitions program in Hayden Gallery and Hayden Gallery Corridor, and the curatorial care of the M.I.T. Collections. The Office of Exhibitions also provides staff support for C.V.A. projects.

From September, 1974, through summer, 1975, the Office of Exhibitions presented seven exhibitions in Hayden Gallery, five of which were organized at M.I.T. Seven exhibitions were shown in Hayden Corridor Gallery. Six of these, representing the work of local artists, were organized at M.I.T. One exhibition was organized in cooperation with the Council for the Arts at M.I.T. for the M.I.T. Faculty Club.

Hayden Gallery Exhibitions

Kurt Kranz: Bauhaus and Today
September 23-October 12, 1974

A retrospective exhibition, organized by Stephen Reichard for the Smithsonian Institution, included paintings, watercolors, drawings, assemblages, photomontages, folding objects, and films exploring serialism and kinesthetics by this German artist who entered the Bauhaus in 1930. Kranz' pioneering work in form sequence has earned him a distinguished international reputation. The artist was present at the opening and spoke informally to a group of students and guests, including members of the Boston Chapter of the Goethe Institute. An exhibition catalogue by Max Bense and others was available in the gallery.

Brassai: The Eye of Paris
October 18-November 16, 1974

Katherine Porter  
November 22-December 21, 1974  
An exhibition organized by Professor Wayne Andersen. New paintings by a young Boston artist who is rapidly attaining a national reputation. Working with an arbitrarily-established grid, Porter explores the harmonies and antitheses generated by obliterated sections, broken patterns, painterly handling and variations of color, tone and line. Katherine Porter was present at the opening of the exhibition. An illustrated catalogue by Wayne Andersen was available in the gallery.

Video: Art-In-Process  
January 7-February 11, 1975  
Richard Leacock and his staff created a series of video events which included all stages of production from rehearsal to performance. Professionals with the assistance of M.I.T. students created humanities-oriented tapes of theater, dance, poetry reading and musical performance. Seating was provided for gallery visitors to watch art-in-process. Performances and taped video presentations varied constantly during this I.A.P. project. A free program by Richard Leacock and others was available at each performance.

Drawings by Five Abstract Expressionist Painters  
February 21-March 26, 1975  
An exhibition consisting of approximately 80 works on paper by artists who were among the leaders of the Abstract Expressionist movement: Willem de Kooning, Arshile Gorky, Jackson Pollock, Franz Kline and Philip Guston. For all these artists, drawings were, and are, an important part of their work, frequently equaling the directness and strength of their painting. The exhibition revealed the aims they held in common as well as the diversity of their individual vision. Philip Guston was present at the opening of the exhibition. A catalogue by Eila Kokkinen, who organized the exhibition, was available in the gallery.

Visual Dharma: The Buddhist Art of Tibet  
April 4-May 7, 1975  
An exhibition organized in cooperation with the Nalanda Foundation. Over 50 masterpieces of Tibetan sacred art including thangkas and three-dimensional objects. The exhibition was selected from museums and private collections by Chogyam Trungpa, Rinpoche, a respected lama and scholar of Buddhist art. Pieces date from the Fifteenth Century to the present and represent a wide variety of styles. A catalogue of the exhibition, including an essay by Chogyam Trungpa, was prepared by the Office of Exhibitions. A film of the exhibition was made by Richard Leacock.

Bronzes from the M.I.T. Collections: Recent Acquisitions and Loans  
May 17-July 16, 1975  
An important selection of works by Jacques Lipchitz was made available by Yulla and Lolya Lipchitz and Mr. and Mrs. Ralph Pomerance through the efforts of the M.I.T. Council for the Arts and the Committee on the Visual Arts. A major Max Ernst was made available through the generosity of the de Menil Family Collection. Also featured in the exhibition were two renowned sculptures acquired by M.I.T. in 1973: Auguste Rodin's Large Head of Iris and Emile-Antoine Bourdelle's Tragic Mask of Beethoven.

New loans to M.I.T. included the following:

Committee on the Visual Arts

2) Jacques Lipchitz. Figure. 1926-30. Bronze. Five-year loan by Yulla and Lolya Lipchitz.


4) Jacques Lipchitz. Song of Songs. 1945-48. Five-year loan by Mr. and Mrs. Ralph Pomerance.


Hayden Corridor Gallery Exhibitions

Carl Nesjar: Photographs
September 23-October 12, 1974

Carl Nesjar, a native Norwegian artist and former Fellow at M.I.T.'s Center for Advanced Visual Studies, is known internationally for his sculptured building murals, free-standing concrete reliefs and "Ice-Fountains." His black and white photographs are direct observations of the constantly changing physical states of water in interaction with natural forces.

Natalie Alper: Recent Drawings and Watercolors
October 19-November 16, 1974

Natalie Alper, a Boston painter, is a member of the faculty of the Museum School of the Museum of Fine Arts, Boston. This exhibition was selected from her recent work on paper. The underlying concern of the artist is with the expansion and contraction of light, a sense of which is created by a subtle modulation of values.

Selections from 'The Grand Tour' Photographs by Amelia Bent Burnett 1908-1912
November 22-December 21, 1974

Amelia Bent was a gifted amateur whose observations were not overwhelmed by strange environments or foreign customs. From 1908-1912 she traveled across the United States and on to a world tour, photographing splendor, poverty and daily activity with equal grace.

Nan Arghyros: Drawings
January 10-February 8, 1975

Nan Arghyros, a Boston artist, has been an instructor of the history of art at M.I.T. from 1968 through 1974. In the last several years she has been working on a series of drawings which may be called "portraits" of vegetables. Done in pencil in an immaculately refined technique, the vegetables evoke biomorphic associations suggestive of forms full of the possibilities of transformation into other shapes.
Amos Chan: Photographs  
February 21-March 23, 1975  
The photographs in this exhibition were taken by a young artist during travels to Nepal and the Far East, and more recently in the American Southwest.

Andrew Tavarelli: Drawings  
April 4-May 4, 1975  
Recent drawings by Boston artist Tavarelli result from his interest in textural possibilities of media such as graphite, chalk and conte crayon.

Selection of Balloon Prints from the Theodore N. Vail Collection  
May 17-July 16, 1975  
This exhibition traces man's attempts to fly, from the mid Eighteenth Century to the early Twentieth Century. Prints and extended captions document the invention and flight of balloons and airships from early experiments to the first dirigible. The heroic and scientific are side by side with the foolhardy and hazardous, relating both triumph and failure of pre-airplane navigation.

Other Activities

An exhibition of photographs by Alice Curtis Desmond was organized for the M.I.T. Faculty Club in conjunction with the Council for the Arts. Mrs. Desmond has won many photography awards. Her family has been a sponsor of M.I.T. activities for many years. A dinner was held in her honor on November 18. A program entitled, "Video: Art-In-Process" included performances of dance, music, theater, and video presentations. Evening performances on January 28 through February 1, 1975, were given to standing-room-only audiences.

Volunteer Program

Mrs. Marianne Teuber, Mrs. Esther Felix and Mrs. Lucy Martin volunteered to make an inventory of the M.I.T. Permanent Collections in public and private spaces throughout the Institute. The volunteers located and gathered catalogue information for over 400 objects. Their notations will be incorporated into a new registry system developed by the Office of Exhibitions last year.

Curatorial and Administrative Internship

Lisa Mirin, a senior at Wheaton College, received academic credit for time spent as an intern in the Office of Exhibitions. Her practical training in all phases of our activities was supplemented by readings in museology.
Committee on the Visual Arts

Grants Activity

During the 1974-75 academic year, the Office of Exhibitions was awarded two grants totaling $9000:

1) The JDR 3rd Fund—to assist with the publication of the exhibition catalogue Visual Dharma: The Buddhist Art of Tibet-- $5000.

2) Council for the Arts at M.I.T.--to make a documentary film of Visual Dharma: The Buddhist Art of Tibet, under the direction of Professor Leacock, Head of the Film Section, Department of Architecture-- $4000.

Publications

Exhibition Catalogues included the following:


The M.I.T. Art News was first published by the Committee on the Visual Arts in fall, 1972, as part of its efforts to bring M.I.T. students into close contact with all areas of the visual arts. The M.I.T. Art News is published at the opening of each term to alert students to subject offerings, exhibition plans, and new programs and events. The publication provides the community with a broad range of opportunities for experience and participation in the visual arts. It is also intended as a vehicle of information on the history and development of the Institute as a visual environment.

WAYNE V. ANDERSEN

Division for Study and Research in Education (D.S.R.E.)

The year 1974-75, the second year of D.S.R.E., was again one of development and growth. The main emphasis was placed on the development of the two major foci of the Division, the theory of individual learning and the theory of institutional learning. A great deal of the Division's activity was devoted to the development of the newer of these foci, institutional learning. During the fall term, the Division held a small faculty seminar devoted to this topic. The seminar, which was led by Professors Donald A. Schon and Benson R. Snyder, had among its participants Professors Chris Argyros of Harvard University, Thomas F. Jones, Visiting Professor of Engineering and Education, William T. Martin, Martin Rein of the Department of Urban Studies and Planning, Dr. Barbara S. Nelson, Assistant to the President and Chancellor, and Sir Geoffrey Vickers of Goring-on-Thames, England, Visiting Senior Lecturer in the Division. Several ideas for possible research areas as well as ideas for a graduate subject grew out of the work of the seminar. As a consequence of the seminar, Professor Snyder and Dr. Nelson jointly conducted a graduate subject on institutional learning during the spring term.
During the year, the Division continued its Wednesday luncheon seminars at which individual members of the Division reported on their work. These seminars furnished an opportunity for drawing the Division together as a whole to discuss mutual interests. We also were fortunate in having several distinguished speakers from other institutions.

In 1974-75 the Division worked out a cooperative liaison relationship with Austin College in Sherman, Texas, whereby the College and D.S.R.E. will exchange ideas on work of common interest. At least once a year representatives from each of the two groups will meet together to discuss topics of mutual concern.

The work of the Division was greatly aided by a generous grant of $60,000 from the Ford Foundation to enable development and documentation of new foci.

Personnel

Jeanne S. Bamberger was promoted from Research Associate to Associate Professor jointly in the Division and the Department of Humanities, effective July 1, 1974. Dr. Jones, Distinguished Professor, University of South Carolina, was appointed Visiting Professor for the academic year jointly in the School of Engineering and the Division. Dr. Jones has been appointed Vice-President for Research at M.I.T. beginning July 1, 1975. He will continue to hold an appointment as Visiting Professor jointly in the Department of Electrical Engineering and Computer Science and the Division. Dr. K. Nagaraja Rao, Senior Research Associate in M.I.T.'s Center for Policy Alternatives, was appointed Senior Lecturer (part-time) in the Division while continuing his appointment in the Center. Sir Vickers visited the Division during most of the fall term as Senior Lecturer. Dr. Nelson was appointed Lecturer (part-time) in the Division beginning with the second half of the academic year. Professor Roy Kaplow was given a joint appointment in the Department of Materials Science and Engineering and the Division effective July 1, 1975. Dr. Harold Abelson was promoted from Instructor to Lecturer jointly in the Division and the Department of Mathematics effective with the beginning of the 1975-76 academic year.

Among short-time visitors during the year were Professor Jerome S. Bruner, University of Oxford; Professor Tom Burns, University of Edinburgh; Dr. Harvey A. Cohen, La Trobe University, Australia; Professor Harry Judge, University of Oxford; Olivier De Marcellus, University of Geneva, Switzerland; Herbert N. Nwagha, College of Science and Technology, Nigeria; Professor Ingrid N. Sommerkorn, Universität Bremen, Germany; and Dr. Akio Yanagimachi, Technical Research Laboratories of Nippon Hoso Kyokai (Japan Broadcasting Corporation), Japan. Dr. Yanagimachi's appointment was jointly with the Division and the Center for Advanced Engineering Studies. Both the visiting faculty and the short-time visitors contributed significantly to the work of the Division during their time here.

In 1973-74, three Special Lecturers were appointed as the result of an international search in the first year of a continuing and important program for the Division. These three Special Lecturers were Steven T. Rosenberg, Department of Psychology, Carnegie-Mellon University; Ben-Zion Shanon, Department of Psychology, Stanford University; and James L. Stansfield, Bionics Research Laboratory, University of Edinburgh. These three Special Lecturers have been reappointed for academic year 1975-76, and two new Special Lecturers will be joining the Division. They are L. Muriel Birchette, Department of Psychology, Yale University; and Andrea Di Sessa, Department of Physics, M.I.T.
In July, 1974, Elaine Medverd joined the Division as Administrative Officer. Ms. Medverd came to the Division from the position as Special Assistant to the Dean of the Liberal Arts College at Boston University.

This is the second and final year in which I have served as Director of the Division. Professor Snyder has been appointed Director of the Division beginning in fall, 1975. He has played a key role both in the planning of the Division prior to its establishment and in its operation and development during its first two years. All of us in the Division look forward to working with him in this new capacity.

**Graduate Work**

Students interested in education research were able to work under an interdisciplinary Ph. D. program administered by the Division in collaboration with M.I.T. departments. Eight students were enrolled in this program during 1974-75, an increase of five from the previous year. The number will increase to approximately 12 during 1975-76.

The Division also is cooperating with Course XXV in a new Master of Science program with an emphasis on science and education. Several students have shown interest in this program which will be initiated in fall, 1975.

**Academic Program**

The number of regular subjects given by D.S.R.E. during the fall and spring terms increased in number, in enrollment, and in breadth of coverage. Several of the regular subjects as well as some of the key seminars were led by two or more faculty members, with credit given both by the Division and by an academic department. These offerings gave our graduate students access to a broad set of subjects in the Division's areas of specialization, and also served as elective subjects for both undergraduates and graduate students from other parts of the Institute.

**The Lilly Post-Doctoral Teaching Award Program**

Near the end of academic year 1973-74 the Division received a $50,000 grant from the Lilly Endowment, Inc. to be used for Lilly Post-Doctoral Teaching Awards for academic year 1974-75. This program was coordinated by Professor Kaplow and had 13 participants who were assistant professors and post-doctoral instructors from 11 of M.I.T.'s 24 academic departments. The primary purpose of the program was to study various aspects of the teaching-learning interaction with a view toward enhancing the teaching effectiveness of participants. This grant was renewed for academic year 1975-76 and will be jointly coordinated by Professors Kaplow and Snyder. While there will be some change in the format of the program next year, the general purpose will remain unchanged. Interested
individuals may make proposals in support of work they would like to do under the program. In this manner, the Division hopes to be able to meet the needs and interests of the 12 to 15 participants who will be selected for the program.

WILLIAM T. MARTIN

Harvard-M.I.T. Program in Health Sciences and Technology

Educational Programs

The Curriculum in the Biomedical Sciences

During the past year the Curriculum Committee with Dr. David W. Hamilton as Chairman has been engaged in an intensive review and evaluation of the subjects offered during the past four years. This review is being carried out in collaboration with faculty members responsible for these subjects. Students in the Program participate actively in this evaluation. The subjects are reviewed in terms of these curricular objectives: 1) progressive penetration and integration of the physical sciences and of molecular and cellular biology into the human biological and medical sciences; 2) the fostering of independent study and active student participation in the presentation of each subject; 3) teaching by a small number of dedicated faculty members who are in attendance throughout the period of the subject offering and who help to assure continuity and a high quality of teaching. In these subject reviews, the teaching staff of each subject presents the content of the subject, its strengths and weaknesses, and the plans of the staff for future evolution of the subject. The members of the Curriculum Committee, the teaching staff, and the students then engage in open discussion of the subject and offer suggestions for improvement. This review gives the faculty members of each subject a better understanding of the other subjects and enables them to relate their efforts more productively to the curriculum as a whole.

The Joint Faculty Committee has adopted the policy of designating subjects as Health Sciences and Technology (H.S.T.) offerings when they are supported at least in part by the H.S.T. Program and when they are subject to review by the Curriculum Committees of the Program. Currently, 26 subjects are supported by the Program.

The effective integration of relevant aspects of social sciences into our curricular offerings is an important objective of the Program. Significant steps toward this objective have been taken during the past year. H.S.T. subject Topics in the Economics of Health Care, taught by Alan Detsky was offered for the first time. Professor Charles Fried and Dr. Sissela Bok offered Ethics and Decision-Making in Medicine. The success of these offerings augurs well for the development of additional offerings on the social determinants of health and the social consequences of illness, the sociology of the health professions, and the politics of health care.

The Curriculum Committee has been engaged in the development of appropriate offerings in genetics, pharmacology, immunology, and quantitative physiology. Still unmet is the need for study and teaching of the biological determinants of human behavior.
Admission of students into the M. D. program is determined by a Faculty Committee of which Dr. Herman N. Eisen, Professor of Biology at M.I.T. is Chairman, and Dr. Walter H. Abelmann, Professor of Medicine at Harvard Medical School, is Co-Chairman. This year the application procedure was modified to encourage only applicants with serious and informed interest in the H. S. T. Program. Applicants were required to submit an essay describing their special interest in the Program in addition to completing the standard admission forms to Harvard Medical School. A summary of the Admission Committee activities for 1974-75 is as follows:

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<th>HARVARD-M.I.T. PROGRAM IN HEALTH SCIENCES AND TECHNOLOGY</th>
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<td>Representation in the Applicant Pool (Total N = 349)</td>
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<td>Representation in the class beginning September, 1975 (Class of '79)</td>
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<td>Schools:</td>
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<td>Other</td>
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<td>Women:</td>
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<td>Undergraduate Majors:**</td>
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<td>Biological Sciences***</td>
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<td>Physical Sciences</td>
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<td>Minority Applicants:</td>
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<td>Ph. D.'s:</td>
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* Yale, 3; Columbia, 2; Stanford, 2; 1 each from Wellesley, Michigan, McGill, Texas.

** Because of double majors (Biology and Chemistry, Chemistry and Physics, etc.) the sum of biological and physical sciences exceeds 25 (no. of students in class).

*** Includes biology, biochemistry, biophysics.

The newly admitted Class of 1979 has seven students from M.I.T., seven students from Harvard College, and 11 students from other universities. More than half of the students
have concentrated in the physical, engineering, and chemical sciences, and the others have their principal preparation in the biological sciences. The quality of the successful applicants is outstanding.

This year marks the graduation of the first class of H.S.T. students to receive the M.D. degree. The performance of the students has been the source of much gratification to the faculty members in the Program. Their success is reflected in the excellent internship appointments which they have received.

**Medical Engineering**

A Task Force of faculty members of M.I.T. and Harvard Medical School has studied the issues and problems associated with the development of medical engineering and medical physics in the universities and in the teaching hospitals. The Task Force is chaired by Professor Laurence R. Young of M.I.T. The principal recommendations of the Task Force include: the organization of Medical Engineering departments in the Harvard teaching hospitals with educational, research, and service responsibilities and with status equivalent to that of the clinical departments should be centrally coordinated through the Program in Health Sciences and Technology; the development of formal degree programs in Medical Engineering and Medical Physics at the graduate level including the Ph.D. degree, with curricula comprising a series of clinical engineering clerkships in Radiology, Anesthesiology, Orthopedics, Cardiology, Neurology, Ophthalmology, Otology, Surgery, Hospital Safety, and Rehabilitation Medicine.

The establishment of the Rehabilitation Engineering Center at the Children's Hospital Medical Center and at M.I.T. is an important element in the development of medical engineering in the H.S.T. Program. Dr. William Berenberg, Professor of Pediatrics at Harvard is the Director, and Dr. John Hall, Professor of Orthopedic Surgery at Harvard and Professor Robert W. Mann of M.I.T.'s Department of Mechanical Engineering serve as Co-Directors.

A Biomedical Engineering Center is being established with the support of a newly awarded grant from the National Institutes of Health. This Center is designed to promote the applications of microprocessor technology in the development of clinically valuable medical instrumentation. This Center, physically located at M.I.T. and in the Harvard teaching hospitals, should play an important part in the further development of medical engineering in the H.S.T. Program. M.I.T.'s Professor Roger G. Mark, of the Department of Electrical Engineering and Computer Science, is Director of the Center.

The development of a predoctoral training program in medical physics, under the supervision of Professor Gordon Brownell of the Department of Nuclear Engineering and the Massachusetts General Hospital, and of Professor Bengt Bjarnard of the Faculties of Medicine and of Public Health of Harvard, is another significant element in the H.S.T. Program.

An educational program on ultrasound in medicine is being designed for graduate physicians who will study the physics and engineering of ultrasound and its clinical applications. It is being developed by Dr. James Adelstein, Dr. Irving A. Berstein, Professor Brownell, Professor Karl Ingard, Professor Padmakar Lele, Dr. Edward Smith and Professor Young.

There are 33 subjects in medical engineering and medical physics currently sponsored or supported by the Program. The Interdepartmental program in Biomedical Engineering which is supported by the H.S.T. Program has six students enrolled as candidates for the doctoral degree.
Harvard-M.I.T. Program in Health Sciences and Technology

Research and Development

The following new programs have been activated during the past year: 1) Studies of "Optimization of Dose Distribution in Cancer Radiation Therapy" are being pursued with the support of a grant of the National Cancer Institute. These studies involve the Harvard Joint Center for Radiation Therapy, and M.I.T.'s High Voltage Engineering Laboratory, Department of Mechanical Engineering, Artificial Intelligence Laboratory, and the Draper Laboratory. The principal investigators in this program are Dr. Martin B. Levene and Professor Henry M. Paynter; 2) a Biomedical Engineering Center for the application of microprocessor technology to the development of medical instrumentation has been established with the support of the National Institutes of Health. This Program is under the direction of Professor Mark who serves as Director, with Dr. Stephen K. Burns as Technical Director; 3) a program in Health Care Technology sponsored by the Robert Wood Johnson Foundation is designed to develop information and communications systems especially suited to the care of ambulatory patients. This program is under the direction of Professor Mark and a Steering Committee.

Continuing research development programs include: 1) The Interdisciplinary Program in Biomaterials Science, now in its fourth year of operation with the support of a Program Project Grant of the National Heart and Lung Institute. This research program is supervised by Professor Mann of M.I.T. and a Steering Committee of 11 faculty members. The research is evaluated annually by an Advisory Board whose chairman is Dean Robert A. Alberly of the School of Science of M.I.T. A proposal for the continuation and expansion of this program has been submitted; 2) a research program in nuclear medicine involves six collaborative research projects. The overall program is under the direction of Dr. Adelstein and Professor Brownell; 3) an initial study on "Priorities for Health Research Relating to Energy System Development" supported by the National Science Foundation has been carried out under the supervision of Dean James Whittenberger of the Harvard School of Public Health and Professor David J. Rose of the Department of Nuclear Engineering of M.I.T. Based on this initial study, a significantly more expanded research program is being developed; 4) the Rehabilitation Engineering Center has been described above in the section on Medical Engineering; 5) "The Diagnosis and Treatment of Muscular Disorders Resulting from Upper Extremity Stroke." This research effort involves Professor Thomas B. Sheridan of the Department of Mechanical Engineering of M.I.T. and Dr. Robert Leffert and Dr. Robert Young of the Massachusetts General Hospital. Dr. Irving A. Berstein, Program Officer for Research and Development, continues to play a crucial role in the organization and management of these collaborative research programs.

Administrative Structure

The Joint Faculty Committee was established as the senior faculty body of the Program. During the past year, the Committee defined the criteria for membership in the faculty and staff of the Program, received and discussed the reports of the Curriculum Committees, the Admission Committee, and the Research and Development groups engaged in Program sponsored activities, and initiated requests for the establishment of ad hoc faculty committees to provide for the appointment of faculty members needed for the Program in Functional Anatomy and in Quantitative Physiology.

The Planning Committee of the Program chaired by Provost Walter A. Rosenblith of M.I.T. and Dean Robert H. Ebert of the Faculty of Medicine of Harvard reviewed the accomplish-
ments and needs of the H.S.T. Program and studied the establishment of Harvard-M.I.T. School of Health Sciences and Technology. When the Program was established in 1970, the M.I.T. faculty, the Faculty of Medicine of Harvard, and the Corporations of the two universities, voted to establish a joint School of Health Sciences and Technology when appropriate resources were available. The Planning Committee reached the conclusion that the time was indeed opportune for establishment of the School of Health Sciences and Technology, and that the prospects for additional financial support were promising.

Financial Resources

As of June 30, 1975, endowment funds received or pledged totaled $5,544,000 of which $1,492,500 was raised during the past year. Operating funds received or pledged in 1974-75 totaled $394,188. Twenty-one proposals remain under consideration. Dr. Walter L. Koltun, Assistant Director for Resources, is in charge of these activities in the Program.

IRVING M. LONDON

Independent Activities Period (I.A.P.)

According to responses to a questionnaire and other data we have gathered, the 1975 Independent Activities Period was as popular among students and faculty as its four predecessors. In its second year as a permanent part of the academic calendar, I.A.P. continued to meet its original objectives of eliminating the January "lame-duck" period, easing the between-semesters rush for academic and administrative problems, providing some "fallow" time to be used by students and staff for research and study at a more leisurely and independent pace, and providing opportunities for flexibility in learning and teaching styles.

Questionnaires mailed to a sample of students and faculty indicated that 86 percent of teachers and 78 percent of students are on campus 75 percent or more of the time during I.A.P. As in previous years, about 90 percent of the students and faculty felt I.A.P. was good for them personally. They were heavily engaged in teaching and research; most of it was concentrated in their usual area of work, but substantial portions of their efforts were devoted to the nearly 500 activities generated explicitly for I.A.P. and advertised in the I.A.P. Guide.

This year's biggest attractions were Gloria Steinem's lecture, which packed Kresge; the M.I.T. Spelling Bee, which held an audience of hundreds past midnight and was organized by undergraduate Harvey Elentuck; and "Nutrition of the Pepsi Generation," a Nutrition and Food Science seminar that drew over 400 attendees. Such one-time events accounted for about 21 percent of the 500 activities listed in the Guide; almost as many met two or three times, and about 59 percent met as often as weekly or daily. These data indicate that for large numbers of students and faculty, I.A.P. involved a substantial time commitment. Our data also show that 75 percent of I.A.P. activities were semi-academic, 5 percent academic, and 20 percent nonacademic. "The Great Invent-a-Toy Competition," "Technical Oral Communications," and "The Economics of the Great Depression and Its Lessons for Today" were 1975 examples of the first category; Calculus Subject--18.002E exemplified the second; and "Mixology" and "How to Pray at M.I.T." the third.
Independent Activities Period

The activities announced in the Guide provide only a partial profile of what occupied students and faculty during the month. The questionnaire asked teachers if they felt I.A.P. allowed them to do something new and different, and 70 percent of the responses were affirmative.

The questionnaires revealed significant differences in the ways undergraduate and graduate students used I.A.P. Among undergraduates, the ratio of time spent on I.A.P.-generated academic activities to that in self-generated academic pursuits was about 5 to 1 (25 percent to 6 percent). Among graduate students, the balance shifted in the other direction, showing they spent about 40 percent of their time in academic efforts such as thesis work and working as M.I.T. teaching or research staff, and 26 percent of their time on I.A.P. academic work for credit, structured academic work not for credit, and independent study. In the categories of recreation, rest, and travel--undertaken quite in accordance with the original objectives of I.A.P.--undergraduates spent 37 percent of their time, and graduate students, 15 percent. Undergraduates also spent more time at noncareer related jobs (10 percent) than graduate students (5 percent). Anecdotes appended to questionnaire responses made it clear that both groups were getting together on their own for laboratory, study, and recreational projects.

Academic credit remains a low-key aspect of I.A.P. Only 310 grades of "P" were granted, 198 to undergraduates (102 of these were for calculus, which the Department of Mathematics will not offer during the 1976 I.A.P.) and 112 to graduate students. That was roughly equivalent to previous years. Only 23 letter grades were granted, one to an undergraduate and 22 to graduate students. In 1974, which was the first year in which letter grades were authorized for I.A.P. activities, the number of undergraduate letter grades was as high as 32. Over 330 additional roll cards were issued in 1975, but, since these were for thesis, UROP, and similar projects, we feel they do not represent academic work generated by I.A.P.

The I.A.P. Policy Committee, which is the student-faculty group charged with overseeing and evaluating I.A.P., undertook numerous statistical analyses of the data obtained from questionnaires and the Guide to calibrate the accuracy of conclusions we had come to in the past based on straightforward reading of our data. One interesting fact these analyses supported was the broad representation of all ranks of faculty in I.A.P. activities (of the type advertised in the Guide) and the extent to which faculty share the load of serving as activity leaders from year to year. A very high proportion of the Guide's 500 activities (230 or 51 percent were organized and led by faculty, and a high proportion of these were semi-academic activities involving small groups of students that meet weekly or more frequently. Moreover, it is not just junior faculty who are active in I.A.P.; full professors' participation was approximately the same as their proportion of the total faculty (208/492, or 52 percent). Of the 280 faculty listed as leaders of activities announced in the final Guide for I.A.P. 1975, 148 names, or 52 percent, were different from those listed for 1974.

In general, I.A.P. has established and is sustaining its place in the Institute calendar as an opportunity for experiences and activities for both teachers and students that would be difficult, if not impossible, to achieve during the regular term. More so than in previous years, the I.A.P. Policy Committee attempted to extend the activities of I.A.P. beyond students and faculty to the whole M.I.T. community. The Employees Open House on March 21, 1975, which attracted 5,000 people to the campus, was the most outstanding result of this effort. When the I.A.P. Committee queried employees, they said that they seldom had a real opportunity to see M.I.T. or to show it to their families and friends. Because of the risk of bad weather in January, we decided to shift the date to early spring and enlarge the sponsorship beyond the I.A.P. Committee to the whole Institute. A series of lectures given this year by the Department of Physics and directed explicitly to secretarial personnel was very popular and was another excellent example of these efforts.
Working with the Office of Personnel Development and groups of employees, we hope to enhance the beneficial impact on the Institute of I.A.P. by including in it all the groups that comprise the M.I.T. community.

JOEL ORLEN

Joint Center for Urban Studies

This year has been a very active and productive one for the faculty, students, and research staff of the Joint Center. The Center has continued its primary research focus in the field of housing while undertaking related research in the fields of public service delivery and the interrelation of social stratification with social policy. The major study of Housing Allowances, begun in June, 1972, was completed in April, 1975, with a two volume technical report and a summary report for policymakers. The analyses and findings contained in these reports have received wide and favorable attention from persons in government and universities concerned with the concept of direct cash assistance as a policy for providing adequate housing to low income people. Work continued on refining and validating forecasts of national and metropolitan housing needs over the next decade. Research on the causal factors of instability in housing markets continues, and has led to an effective quarterly forecasting model of housing starts in the nation. A Joint Center working paper on the role of pension funds in the mortgage market has received considerable attention and will have some direct effect on forthcoming Congressional hearings on the financing of housing.

Four newly funded research projects were begun in July, 1974: An Analysis and Modeling of Neighborhood Level Evolution and Decay; A Forecasting Model of Interregional Migration; An Exploration of the Interrelations of Social Stratification, Economic Success, and Social Policy; and A Study of the Effects of Municipal Employee Unions on the Delivery of Municipal Services. During the year, Professor Bernard J. Frieden, Director of the Joint Center, and Professor Arthur P. Solomon, Associate Director, and other research members were active in a variety of forums to speak about their research, testify before Congress, or participate in policy seminars.

A Review Committee, comprised of M.I.T. and Harvard University deans, department heads, and senior faculty, as well as representatives from our Policy Advisory Board and Visiting Committee, was appointed by the presidents of M.I.T. and Harvard to review the intellectual scope and activities of the Joint Center in recent years, and to advise on the direction for future activity. In summary, the Review Committee found that the decision taken in 1971 to move from a widely dispersed urban research agenda to a primary, though not exclusive, focus on one major policy field -- housing -- has proven to be successful. The Committee recommended that research in housing be continued and strengthened as a primary field, while a renewed effort be made to broaden into other social and economic policy fields of interest to Harvard and M.I.T. faculty members.

Professor Frieden, who ably led the Joint Center through a period of substantial transformation and strengthening from 1971 to 1975, retired as Director at the end of June, 1975. He will be on sabbatical leave with a Guggenheim research grant at the University of California at Berkeley, during 1975-76 before returning to M.I.T. as Professor of Urban Planning in September, 1976. Professor Solomon, of the Department of Urban Studies and Planning at M.I.T., who has served as Associate Director of the Joint Center since 1972, was appointed Director beginning July 1, 1975.
Housing Research

National Housing Needs

The aim of the Joint Center's housing needs study, begun in 1972, is to develop an informational base and forecasting methods necessary to understand more fully the housing needs for the nation over the next decade. With the ability to make seasonally valid forecasts of housing needs, we can test the effects of any proposed policies and programs, anticipate overall demands for housing, and derive the corollary demand for land, labor, building materials, and mortgage capital. Our first major publication in this project was published in 1973: America's Housing Needs: 1970-1980. During 1974-75, we concentrated on assessing the accuracy of our 1970-1980 construction forecasts and developing a methodology to forecast construction by specific structural type. We have found that our overall forecast of 23.3 million units to be built during the 1970s has proved to be reasonably accurate. Because of existing data limitations, however, its accuracy appears to be due partly to compensating errors: our estimate of household foundation appears to be low, while our estimate of construction in excess of household growth appears to be too high. Also, our estimate of migration flows between cities and rural areas was incorrect in some cases. Our current research on intermetropolitan migration will provide a much improved conceptual and empirical basis for future forecasts.

During the year, we started work on forecasting construction by structure type with an emphasis on determining consumer preferences for housing. We have found that 1) the shift toward occupancy of mobile homes is, in the aggregate, taking place among households which traditionally occupied conventional single family units; and 2) the shift of the past 15 years toward an increase in the production of multiunit structures has resulted from demographic shifts rather than a shift in housing preferences. More work remains to be done analyzing 1960 and 1970 Census Bureau Public Use sample tapes, construction reports, and current population surveys before we will be in a position to forecast structure types more definitively.

This research, directed by Professor Frieden and Dr. David Birch, Senior Research Scientist, has been performed by Dr. Reilly Atkinson of the Joint Center research staff.

Neighborhood Evolution and Decay and Inter-Area Migration

The Joint Center was awarded two major grants by the U.S. Department of Housing and Urban Development (HUD) to analyze the evolution and decline of neighborhoods and the migration patterns from region to region across the United States. Both studies are related to work that the Joint Center has already accomplished (and published in America's Housing Needs: 1970-1980) on projections of housing and levels of household deprivation. The earlier research strongly suggested that decaying neighborhoods and trends in migration play important roles in determining how many housing units will be needed in the future, where they will be needed, and the quality of the existing housing stock. The new studies will provide the opportunity to investigate these factors in much depth.

The specific purpose of the neighborhood study, which will run almost three years, is to attempt explanation and anticipation of the process by which neighborhoods evolve and eventually decay (and sometimes are rehabilitated). Field work, based largely on interviews, will be conducted in six metropolitan areas, and a detailed classification will be made of selected neighborhoods according to the age of the housing stock, the price trends...
of the housing units, the racial composition of the population, the prevalence of crime, and the quality of public services. Certain other factors also will be taken into account: the shift of manufacturing employment from city to suburb, court decisions on racial integration in the schools, and a general tightening of the mortgage market. It is clear that pressures causing a neighborhood to change do not lie solely within that neighborhood, so it is imperative to consider the total network of neighborhoods within the larger region if the analysis is to be useful.

The second research project, on migration flows, relates closely to the first and will run for 18 months. A major determinant of neighborhood change is the pressure that migrants from outside bring to bear on a neighborhood or metropolitan area. Different family types require different kinds of houses, schools, and services; yet little is known at this point about the actual composition of these migration flows. This second study will involve a detailed analysis of persons moving from one urban or rural area to another and the reasons governing their choice of location. It will also develop forecasts of future trends in migration.

Most of the effort on the Neighborhood Evolution and Design project during its first nine months went into building the foundations required for the next two years. The literature on models of neighborhood evolution was reviewed and summarized in a report to HUD. After many visits and discussions, four field sites were added to New Haven and Houston; they are Dayton, Ohio; Worcester, Massachusetts; Charlotte, North Carolina; and Rochester, New York. Neighborhood boundaries have been drawn for each metropolitan area, and data collection is now well under way. In addition, we have completed work on an interactive, time-shared data reduction and retrieval package that will be used in the months ahead by the field organizations as well as ourselves as we further develop the model of neighborhood change.

As with the Neighborhood Project, most of our effort during the first year on the Inter-Area Migration Project went into literature review and data collection. We now have amassed a substantial amount of data for counties and groups of counties in the United States, including information on the movement of individuals and individual firms (some 3.5 million of them) as well as measures of the condition of the counties at different times as far back as 1930. We also have completed the first stage in the development of a model to explain locational shifts, and are in the process of enriching it. A preliminary report will be issued in September, 1975. The principal investigator of this research is Dr. Birch of the Joint Center and the M.I.T. Laboratory for Architecture and Urban Planning.

**Low Income Housing Subsidies**

During the year the Joint Center completed a two and a half year study of direct cash assistance for housing. This research, under the direction of Professor Solomon, was undertaken to analyze a broad range of issues critical to the design of a national housing allowance program: the effect of a general housing allowance program on the demand and supply of housing, the effectiveness and equity of alternative payment and earmarking formulas, the determination of eligibility requirements, the integration of direct cash assistance for housing into the existing system of cash and in-hand transfer payments, and the establishment of effective administrative procedures.

A major focus of the research centered on the likely market effects of alternative housing assistance plans. Three separate types of analysis were undertaken. First, since the direct cash payment could take the form of either an increase in income (the housing gap plans) or a reduction in the relative price of housing (the percent-of-rents plans), estimates
were made of the likely change in housing consumption for families of different size, race, and income level. In the second analysis a conditional probability model was used to determine the probable impact of a housing allowance on the likelihood of a household experiencing housing deprivation, that is, excessive rent payments, overcrowding, and/or substandard housing. Again it became clear that a system of direct housing assistance payments would not be equally effective in all Standard Metropolitan Statistical Areas (SMSAs) or among all household types. Increasing the incomes or rent-paying ability of households would obviously decrease the incidence of housing deprivation. However, it would be less effective for minority and extra-large households who appear to face price or quality discrimination or have different tastes for housing. The housing assistance would be less effective, moreover, in SMSAs where there is a price discount for low-quality housing, where the median rent relative to the cost of other goods is high, and where there is a shortage of large dwelling units. The final market analysis involved a long-run simulation. The housing consumption, price, and investment effects of five alternative payment systems were tested through simulation analysis.

Housing gap formulas, with requirements that recipients occupy decent but modest dwellings, were found to be the most efficient and the most equitable plans. In the absence of this earmarking requirement, all payment plans became less efficient, and the choice among plans became less clear. On the other hand, requirements of higher quality housing tend to reduce participation among the poorest families, thereby reducing the equity effects.

Instability in the Housing Industry

This work involved the study of economic fluctuations in residential construction. Research focused on the causes, costs, and effects of cyclical and seasonal fluctuations in home building. Emphasis was placed on the building of an econometric model of the seasonal and cyclical phenomena.

A large portion of this work involved an examination of the role of pension funds in housing finance. The major problem of the housing finance system is a periodic shortage of residential mortgage capital. Since one of the key characteristics of pension plan contribution schemes is the great stability of their net fund flows, they could, with greater investment in housing mortgages, help stabilize the flow of funds to this sector and thus moderate cyclical instability in residential construction. Pension plans, however, generally neglect mortgage investments, with less than three percent of their assets invested in the housing market. This low percentage appears to be due more to traditional patterns of investment, particularly in the stock market, than to economic consideration of investment yields.

The second major segment of this study involved the use of an econometric model to forecast future levels of housing starts. These forecasts, based on various combinations of economic events, were widely used by businesses and government organizations. In one ranking of the accuracy of housing forecasts by several Federal government departments, our forecasts outperformed all other computer and intuitive methods for 1974.

The final contribution of this project involved a substantial amount of direct input into economic policymaking. Dr. Kenneth Rosen, the principal research staff member on this project, testified on three occasions before Senate committees concerned with national housing and economic recovery problems, including the housing tax credit portion of the national tax rebate bill.
Microeconomic Models of Metropolitan Housing Markets

Work continued for the third year on the development of a microeconomic model of metropolitan housing markets. This research is on the functional relationships existing among housing submarkets and their implication for different policies such as housing code enforcement, housing allowances, interest rate subsidies for new construction, rent control, and government construction of public housing.

Professor Jerome Rothenberg, of the Department of Economics and the project's principal investigator, believes that policy impacts need to be evaluated in terms of their net effects on the entire housing market, or metropolitan area, and not simply in terms of their immediate influence on the specific submarkets to which they are directed. The repercussions of market impacts are transmitted among submarkets by the owners' conversion of housing units -- or by taking them off the market altogether -- by demolition or abandonment, and by household moves between submarkets in response to changes in rents, prices, and vacancies. The 1975 Federal income tax credit being given to buyers of new housing, to take a very pertinent example, will tend to depress demand for existing housing of comparable quality, some of which will then become converted to a lower-quality submarket.

Dr. John Pitkin, Research Associate at the Joint Center and Project Manager, is working closely with Professor Rothenberg.

Delivery of Public Services

Municipal Employee Unions: Impact on Service Delivery

The objective of this research is to describe, analyze, and evaluate the impact of municipal employee unions on the delivery of municipal services. Employee unions of police, teachers, social workers, and hospital workers are being studied in the cities of Boston, Detroit, Los Angeles, and Philadelphia. During summer, 1974, activities of the unions were reviewed and case studies were selected. Case examples included: in Boston, a 1967 strike of the House Officer's Association, resulting from a proposed elimination of two-man car patrols and a proposal to impose residency requirements; in Los Angeles, the economic impact of an unlimited cost of living adjustment to the pension system. Working papers on these and other cases are in progress. An advisory panel will be formed to review the technical quality of the papers and to plan a conference on public sector labor relations. Professor Robert Fogelson of the Department of Urban Studies and Planning at M.I.T. and Professor Ralph Jones of the Department of City and Regional Planning at Harvard are the principal investigators of this project which is sponsored by the Metropolitan Division of the National Institute for Mental Health.

Politics of Street Level Bureaucrats

Work continued for a second year on a three-year study of the interaction between public service workers and their clients at the direct or street working level. The empirical research is divided into three parts: 1) Exploring the phenomenon of "slotting," the practice of dividing clients into categories so that the work of bureaucrats is easier to manage, drawing on systematic observation of public housing managers, welfare workers, and emergency room personnel; 2) the quality of interaction between legal service lawyers and their clients; and 3) the reaction of public school personnel to the requirements of a
newly enacted law which makes mandatory the provision of educational services to children with special needs.

In each of these studies arrangements have been made to share findings with the agencies concerned in order to contribute to the development of policies and practices. This research will provide a more general conceptualization and analysis of street level bureaucracies. The principal investigator is Professor Michael Lipsky of the Department of Political Science.

Social Stratification and Social Policy

The Joint Center continued a research program, begun in 1970, which examines the social structure and living standards in the United States. The work analyzes peoples' perceptions of poverty and social standing, consumer patterns of behavior and demand, and the views people hold of the housing in which they live or to which they aspire.

During the past year, new grant support from the Department of Health, Education, and Welfare and the Ford Foundation has enabled the Center to extend research in new directions. The major purpose of this study will be to develop a path model of family income (fully accounting for all sources of income, year to year fluctuations, and long term projections of earnings) to understand more fully how income affects community social standing and consumer decisions. The research will also consider: 1) the role of women in establishing the family's social status and standard of living and the effect of the class standing of a wife's educational background, the number of children she has, and her contribution to family income through labor force participation; and 2) the differentials between black and white families. Work is in process to compare U.S. and European large scale sets of data in these fields. The research is being directed by Professors Lee Rainwater and Christopher Jencks of the Department of Sociology at Harvard and Professor Martin Rein of the Department of Urban Studies and Planning at M.I.T.

Fellowship Program

The Joint Center sponsored eight fellowships for 1974-75 for M.I.T. and Harvard graduate students working on doctoral dissertations. Three such dissertations concern the process of wage determination in contract construction, the response of Boston's city government to revenue sharing, and life styles in one-parent households.

This year the Joint Center Fellows organized four successful meetings in the Fellows Seminar Series. Those presenting the major findings from their doctoral dissertations were Jose A. Gomez-Ibanez, of the Public Policy Program in the Kennedy School of Government at Harvard, on "Federal Assistance for Urban Transportation"; Nathan Betnun, of the Department of Urban Studies and Planning at M.I.T., on "State Housing Finance Agencies and Public Purpose Housing"; Susan Anderson-Khlief, of the Department of Sociology at Harvard, on "Life Styles in One-Parent Households"; and Michael Olneck, of the School of Education at Harvard, on "The Determinants of Educational Attainment and Adult Status Among Brothers: The Kalamazoo Study."

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Seminars

During the academic year, the Joint Center sponsored a luncheon seminar series on a biweekly basis. Seminar speakers included a wide range of persons from universities, research institutions, and government concerned with public policy issues. A partial list of the 1974-75 speakers included: Oscar Handlin, Carl H. Pforzheimer University Professor in the Department of History at Harvard; Barney Frank, State Representative, Massachusetts; Claude Barfield, Jr., Deputy Assistant Secretary for Research and Demonstration, U.S. Department of Housing and Urban Development; and Dr. Ira Lowry, Director, Housing Assistance Supply Experiment, the Rand Corporation.

During the spring term Professor Rein and Professor Jeffrey Pressman, of the Department of Political Science at M.I.T., arranged a seminar series on the development of Federal guidelines and regulations and the role they play in the implementation of Federal programs. Seminar speakers included: Dr. Martha Derthick, Senior Fellow at the Brookings Institution; Professor Frieden of the Joint Center; Professor Lawrence Brown of the Department of Government at Harvard; and Professor Stanley Surrey of the Harvard Law School.

Professor Walter Isard, of the Regional Science Department at the University of Pennsylvania, led a seminar series for faculty and students on regional and urban policy. Speakers at the seminar included: Dr. Benjamin Stevens of the Regional Research Institute, Amherst, Massachusetts; and Professors Robert F. Engle III of the Department of Economics and Aaron Fleisher of the Department of Urban Studies and Planning at M.I.T.

Three meetings of the Joint Center Policy Advisory Board were held to report on research under way at the Joint Center and to discuss issues of current interest in the field of housing.

Survey Research Program

The Survey Research Program, which the Joint Center sponsors with the University of Massachusetts, was particularly active in health research and criminal justice during 1975.

One major undertaking, with a team of physicians and health planners from the Department of Social and Preventive Medicine at the Harvard School of Public Health, entails a study of surgical outcomes from the patient's point of view. Questionnaires have been developed to systematically measure the negative consequences as well as the benefits of elective surgery. This is a first step in an ongoing effort to evaluate and understand the elective surgery process.

The second major endeavor of the Program during the year was undertaken for the Massachusetts Department of Public Health. A state-wide survey of elderly and chronically disabled adults was carried out to assess unmet needs for nursing home beds as well as needs for community-based support services. This project is one of the most intensive and comprehensive of such studies ever done, with very direct policy value for the Certificate of Need Program in the state as well as for planning long-term care facilities and services. The Program recently received a major grant from the Administration on Aging to carry out a follow-up study of this important project, focusing on the stability of support systems and the identification of factors that predict major problems or crises for those who are elderly or chronically disabled.
In the criminal justice area, the Program is responsible for coordinating the evaluation of a neighborhood crime control effort in Hartford, Connecticut. The Program is innovative in that it entails environmental design as well as police and citizen components, both in the analysis of the crime problem and in the substance in the crime reduction efforts. The Program is conducting before and after surveys to measure crime victimization and fear reduction, as well as integrating findings from police record data and other measures of impact.

Program staff have been working with the Commission on the Review of the National Policy Toward Gambling to develop a research agenda designed to assess the impact of the growing interest in legalized gambling.

Publications

During the past year, staff members of the Joint Center published four books and six working papers. The Survey Research Program produced two publications.

BERNARD J. FRIEDEN

Libraries

The academic year 1974-75 in the Libraries represented a continuation of computer-aided services begun last year and progress in microform services and staff development. There were periods of staff unrest, due for the most part to a low professional salary level. The year ended well, however, with positive anticipation of the future.

Cataloging by computer terminals connected to the Ohio College Library Center (OCLC) data bank was fully integrated into the operations of the Catalog Department. This shared catalog system, which the Library joined through the New England Library Information Network, makes it possible to catalog from 50 to 60 percent of the Library's books directly from a growing data base in Ohio, which includes currently approximately 1,355,000 titles. Between January, 1974, when the agreement was signed, and June, 1975, the Library's system became completely operational despite some delay in terminal delivery and in loading M.I.T.'s profile. The Libraries provided careful planning, training, and staff communication to ensure quality standards. Already the Catalog Department staff has been reduced by three positions. Titles cataloged via the terminal are processed within two days, and catalog cards arranged for filing are delivered within ten days.

A valuable side benefit of OCLC has been improvement in the interlibrary borrowing operation. Use of the terminals to locate requested titles has increased the volume of filled requests nine percent over 1973-74; the turn-around time has been dramatically reduced from 13 to seven days. The Libraries now borrow from a greater variety of libraries and can relieve the burden of requests on Harvard University libraries.

The total impact of OCLC participation has yet to be felt. Possible new uses presage its being a dynamic force in library operations.
M.I.T.'s grant from NASIC ended in February, 1975. This grant, given via the Electronic Systems Laboratory (E.S.L.), aided the Libraries in establishing a successful computer-based bibliographical search service. More than 300 searches were performed during the past year; ten staff members were trained as information specialists; and 14 data bases were offered in six locations. Special emphasis was placed on training: as part of the project, the Information Specialists and members of E.S.L. developed training manuals for use by other university libraries as they introduce computer-based information services.

Experience here indicates that a well-trained staff can reduce the computer-connect time on an on-line system by formulating the search strategy carefully. This is important because M.I.T. has used a fee-for-service structure from the beginning. In spite of an average cost of $46 per search, a high percentage of the users expressed satisfaction and considered the search cost-effective. The data base most used was MEDLINE. The highest number of users were in health-related sciences in the Departments of Biology and Nutrition and Food Science. (MEDLINE costs are relatively low--$13 average per search--because of government subsidy, but its heavy use cannot be attributed solely to that factor.)

The summary points of NASIC at M.I.T., Final Report, 1 March 1974-28 February 1975 are worth repeating here:

1) A moderate but growing demand exists for computer-based reference search services.
2) Seventy-seven percent of users perceive the service as cost-effective.
3) Promotional efforts need to be very intense both to increase general awareness of the service and to turn awareness into actual use.
4) Many different promotional mechanisms are needed: the best are oriented toward the immediate, personal needs of the potential user.
5) Cost affects the class of user, but it is only one of many factors that influence a person's decision to use the service.
6) Searches are often interdisciplinary and require several sources.
7) Information specialists need extensive training and practice searching to attain desirable levels of competence.
8) Integration of these services within the library environment may require organization and staff accommodation in addition to the commitment and enthusiasm of participants.

Maintaining the successful NASIC experiment may be difficult with a reduced budget for 1975-76. It is not a substitute reference system but an add-on. The Library administration feels, however, that it has high priority, and plans are being formulated for a small staff to operate a streamlined, centralized service next year.

Other Cooperative Efforts

M.I.T. Library ties with the Greater Boston Consortium of Academic and Research Libraries have been strengthened. The Director has participated in monthly meetings of Consortium directors and staff members have served on Consortium committees. Since February, 12
M.I.T. members have been issued cards to use Consortium libraries; 90 Consortium members have registered to use the M.I.T. Libraries. The use of social sciences and humanities material here has been as great as that of engineering and science. The van that travels daily among the libraries has increased greatly the speed of interlibrary loan delivery. Bylaws of incorporation are nearly ready for consideration of administrative officers at each institution. It is likely that M.I.T. will join formally. Enlarging areas of cooperation with other libraries is one response to reduced library budgets.

The Task Force on the Future of the M.I.T. Library System issued its report in January, 1975. This ad hoc committee was headed by Joel Orlen, Assistant to the Provost, and included members of the faculty, the M.I.T. administration, and the Libraries. The Institute's library needs were projected through 1990; a long-range plan was sketched; and the level of funding that would be required to achieve library performance responsive to the Institute's future needs was indicated. The report assembled pertinent data, computed projected growth, delineated key issues, and developed examples of how added library space might be fitted into the M.I.T. campus. It is a useful springboard for study by groups who will be concerned with defining the future role of Libraries at M.I.T., and it should promote discussion and further detailed studies delineating specific library needs for inclusion in the M.I.T. Leadership Campaign.

Among the new accomplishments of the year was the establishment of a Microform Center in the Hayden basement, combining the microform holdings of the Science and Humanities Libraries. Stacks were removed to make space, new equipment was added, and the area was painted. Because a large part of the collection consists of technical reports, the Technical Reports Checklist was moved from the Science Library to the Center and is now maintained by the staff member in charge of the Center, who also answers directional and informational questions, making the entire basement less baffling to users than it has seemed in the past.

This is the second microform center in the Library system. Barker Engineering Library has had a specially designed and successful microform area for several years. From the Barker experience, it is clear that for user acceptance it is necessary to allocate proper space, equipment, and staff. Acceptance is increased if on-demand fiche copies can be provided. The Barker facility had been offering up to ten free copies, but a recently adopted policy for the Libraries set a charge of $10 per fiche in Barker as well as in Hayden, where fiche copies are provided by the Microreproduction Laboratory. A reasonable charge-for-use policy for new but expensive services, such as fiche duplication, builds restraint into a system and recognizes budget limitations.

A special collection was born this year--the Rogers Collection. By combing the Hayden stacks, more than 1,000 volumes were assembled that belonged to the library of William Barton Rogers, founder and first President of M.I.T.; a few belonged to his brother Henry, some to his wife Emma. Many have his bookplate, signature, or marginalia. Selected titles were exhibited in the Hayden Corridor Gallery in honor of the centennial of the M.I.T. Alumni Association. An attractive brochure with a little-known portrait of Rogers on the front contains an article on the man and his library by President Emeritus Julius A. Stratton. The Humanities Library staff is compiling a complete list of the collection.

The Libraries are grateful to the many friends who give books. Special mention might be made of a few: exhibit catalogs to the Rotch Library from Wayne Andersen; technical books from the estate of Vannevar Bush; from Alice Curtis Desmond a complete set of books she has written; the popular leisure reading books from E. Curtis Powell; books and records to the Music Library from Klaus Liepmann; chamber music scores from Alan Sly; and the gift of its entire library by the M.I.T. Chamber Music Society. Numerous publications came as gifts from institutions and government agencies.
In March, 1975, an Industrial Liaison Symposium was devoted to the services available from the M.I.T. Libraries to members of the Industrial Liaison and Research Associate programs. A large number of industrial librarians and information officers attended. The best techniques for obtaining information were described by several Library staff members, and special services, nonprint areas, and computer-based information services were emphasized. Tours and demonstrations were held.

**Personnel**

Much progress has been made in staff development and continuing education, partially through services offered by the Institute. Many continue to participate and profit from the Administrative Development Program; six are currently enrolled. Adam and Maureen Yagodka of the Office of Personnel Development led a library-wide ten-week workshop for about 25 library employees on Human Processes in Organization. It was a successful experience in fostering ways of achieving open communication among members of working groups and in addressing problems related to attitudes among library staff.

The Libraries continue to benefit from the Institute’s Tuition Assistance Program. Forty-four persons--20 percent of the staff--are taking advantage of this assistance. Of these, five professional staff members are studying for a second master’s degree and 23 biweekly staff members for a master’s degree in library sciences at Simmons College. Fortuitously, this creates a corps of professionally-committed support staff members. When the degree is obtained, however, the graduates face a tight job market, and the Libraries can absorb very few of them into the professional staff. There has been a drastic change in turnover in the past two years--from 17 percent to nine percent in professional staff, and from 51 percent to 27 percent in support staff.

Undoubtedly the major personnel achievement of the year was the upgrading of professional librarians’ salary scale. This was the culmination of two years of intensive effort by the Libraries’ administration. The effort involved investigation of salary levels in other university libraries and a comparison of library staff salaries to administrative salaries at the Institute. This latter process was facilitated by the Libraries’ participation in the Staff Classification Study, introduced by the firm of Robert Hayes Associates. Although implementation and review procedures must be developed, the Libraries can feel that they have achieved salary levels equitable with those of M.I.T. administrative staff of comparable responsibilities and competitive with those of other academic libraries.

In addition to unsatisfactory salaries, the chief element of staff unrest had been the process, and what seemed to many to be the long time taken, of selecting a new Director of Libraries. In July, 1974, Provost Walter A. Rosenblith met with the librarians and explained the entire process. He followed through by meeting with them in February to announce the appointment of Jay K. Lucker, Associate University Librarian at Princeton University, to lead the M.I.T. Libraries in the task of maintaining an excellence that parallels that of the Institute itself.

Two members each of the Barker and Rotch staffs are participating in the Instructional Technology segment of the Telecommunications and Education Sloan Grant, which aims to develop a cable television system at M.I.T. These staff members are experimenting with producing tapes of library tours, library instructional sessions, “Boston Celebrations” (an exhibition by the Center for Advanced Visual Studies at the Institute of Contemporary Art), and construction of a building from drawing-board to ribbon-cutting.
Slow progress is being made in the formulation of collection development policies. Two sets of policies, however, were completed this year with distinction—one for the Aeronautics and Astronautics Library, the other for the Music Library. Such policies for all libraries, reflecting an integrated system, will become imperative if inflation continues and areas of research activity at M.I.T. proliferate.

Effort is necessarily spent each year on matters that impact the following year. The request of the Institute administration for the presentation of the 1975-76 budget in a task-oriented form was difficult to fulfill, although the exercise of attempting it was healthy. The Library administration and Council members worked intensively on it from December through March. Equally difficult will be the implementation of the Libraries' contribution to the Institute's $3.5 million budget reduction goal.

It is with concern, but a determination to make the best of it, that the Libraries enter 1975-76 with 11 fewer positions than existed last year. Attempts will be made to analyze duties, formulate efficient procedures, and maximize utilization of human resources. As part of this effort, a study of serials and journals processes by the Systems Group will be examined. Help in the area of serials control is anticipated from the Cooperative Conversion of Serials Project (CONSER), now inputting data on about 300,000 serials into the OCLC data bank. (CONSER is a national project funded by the Council on Library Resources; OCLC serves as data collector, with the Library of Congress providing bibliographic support.)

One small step toward alleviating the Rotch Library space shortage is under way with the establishment of a Visual Documents Center on the third floor of Building 7. This facility of 1,600 square feet will be a subunit of Rotch, containing slides, photographs, architectural drawings, plans, videotapes, and films, with the associated staff members, catalogs, and equipment. This visual laboratory will house the learning tools of the architect, planner, and environmental designer. The dispersal of one segment of the Rotch operation can be considered only a short-range, survival option. It will release space for additional book stacks and study spaces, but will not relieve the crowded work area.

Space solutions for Rotch, Dewey, and indeed all the libraries in the system, remain on the future agenda, as does a suitable facility to house rare books. Also on that agenda is the clarification of the roles of Archives, Historical Collections, and Technology Studies Group, mentioned in the Director's report last year. The Archivist notes that this has been largely a year for marking time; most of the unresolved problems call for resolution at a high administrative level.

There was a decrease in volumes added in 1974-75 (significantly so in the Dewey Library), and in volumes loaned. Photocopying on rapid copy machines continues to increase. Utilization of the Student Center Library since 1968 has gradually, but steadily, declined.

It is my sense that the year has brought increased awareness on campus of the Libraries and their place in the educational process. Many complimentary letters have been received from faculty and staff, commenting particularly on library orientation tours, bibliographic instruction, and NASIC demonstrations; librarians have taken the initiative in offering seminars such as the one on Census publications, and in producing bibliographies, lists, and guides. Certain items in Library Notes have provoked articles in Tech Talk such as the one on map collections at M.I.T. Indicating the same perception, one librarian concludes her report: "Looking past the profusion of statistics, analyses, and alternate plans, the role of the Libraries in the diversified cultural life of our community seems to me
Provost

perceptibly stronger now than ever before. Teaching styles alter, research orientations shift, and economics fluctuate. Through this constant change, the written and visual records which the Libraries retain and circulate provide a chronicle of human endeavor to challenge the minds and awaken the sense of free and feeling human beings."

I end my term as Director of Libraries with best wishes for success to the new Director. May he experience the satisfaction, pride, and stimulation that I have enjoyed at a superb institution made up of intelligent and compassionate people. My thanks to the students, faculty, administration, and staff, especially to the present and former members of the Library staff, with whom I have worked happily for the past 20 years.

NATALIE N. NICHOLSON

Lowell Institute School (L.I.S.)

During 1974-75, the Lowell Institute School expanded its program of evening courses designed for industrial technicians. Added to the curriculum were subjects in creative photography, engineering drawing, op-amp applications, scientific glassblowing, and television signal processing.

Enrollment for the year totaled 392, with 75 percent of the students completing the certificate requirements. This represents a doubling of the 1973-74 enrollment and supports the concept of offering courses at the technician level which exploit M.I.T.'s position in the forefront of technology and place heavy emphasis on practical applications and laboratory work.

Two intensive, one-week daytime programs also were added to the L.I.S. curriculum and were received enthusiastically. These programs in the operation and maintenance of broadcast videotape recorders and in digital electronics will be repeated during the 1975 summer term. It is particularly encouraging that employers are willing to support their technician-level personnel by permitting them to attend this type of course during normal working hours, and L.I.S. intends to expand these offerings.

BRUCE D. WEDLOCK

Neurosciences Research Program (N.R.P.)

The Neurosciences Research Program is an international and interuniversity organization of scientists operating under the sponsorship of M.I.T. Its main purpose is to facilitate and promote the development of theoretical interpretations bridging the gaps separating the data and concepts of traditional scientific disciplines engaged in research on the nervous system at its various levels of organization: molecular, cellular, neurophysiological, and behavioral. Theoretical breakthroughs are essential if the flood of new information is to be transformed into a scientific understanding of how the nervous system mediates the behavior of animals, including the mental life of man.
There are four main elements in the N.R.P. program: the operation of information exchange activities within the world-wide neuroscience community, the organization of scientific meetings, a program of publications, and a program in graduate and postdoctoral education.

To carry out these activities, a group of approximately 36 N.R.P. Associates, who are leaders in major neuroscientific disciplines, provide advice and guidance to a small professional staff at the N.R.P. Center in the House of the American Academy of Arts and Sciences in Brookline, Massachusetts. In developing scientific activities, the Center staff and N.R.P. Associates enlist the participation of consulting scientists from the neuroscientific community at large; over 1,500 scientists have participated in N.R.P. activities.

The following work sessions and conferences were held during the academic year 1974-75: Opiate Receptor Mechanisms, The Neurobiology of Lithium, Brain Interactions with Weak Electric and Magnetic Fields, Frontiers of Psychiatric Genetics, Electrotonic Junctions, Neuronal and Neurochemical Substrates of Reinforcement, Neuron-Target Cell Interactions.

The scientific programs of stated meetings of N.R.P. Associates are characteristically multidisciplinary. For example, half of the three-day meetings are devoted to reports of the individual Associates on their research during the preceding six months. By the testimony of the Associates, these sessions are intellectually stimulating and productive of new ideas. Similarly, group discussions of carefully selected topics in neuroscience emphasize multidisciplinary discussion. Recent topics have been Changing Concepts of Neuronal Interaction, fall, 1974; Critical Issues in Developmental Neurobiology, fall, 1974; Receptor-Receptor and Receptor-Cytoplasmic Interactions, spring, 1975; and Central Pain Pathways and Pain Modulation, spring, 1975.

During the period, the following Bulletins were published: Dynamic Patterns of Brain Cell Assemblies; Functional Recovery After Lesions of the Nervous System; Conceptual Models of Neural Organization; Language and Brain: Developmental Aspects; Opiate Receptor Mechanisms; Sensorimotor Function of the Midbrain Tectum.


During this period we have been fortunate to have both Dr. Theodore H. Bullock and Dr. Robert Galambos of the School of Medicine, University of California at San Diego, spend a month in-house as visiting Senior Scientists. Other Staff Scientists include: Parvati Dev, mathematical modeling; Frederick E. Samson, physiology and biochemistry; Robert D. Hall, physiological psychology; Diana Schneider, neurochemistry; and Barry H. Smith, molecular neurobiology.

Dr. Shneior Lifson, formerly head of the Chemical Physics Department and Dean of Physical Science, Weizmann Institute, was in residence for a period of three months as the second Aharon Katchalsky Scholar. A noted theoretical chemist, he entered wholeheartedly into collaborative work on neuroscientific problems and was a source of valued intellectual ferment.

A feature of the fall stated meeting was the second F.O. Schmitt Lecture in Neuroscience. The award for 1974 was divided between Dr. Solomon H. Snyder of the Johns Hopkins Uni-
versity School of Medicine, who lectured on "The Opiate Receptor," and Dr. Leslie L. Iversen of the University of Cambridge, whose lecture was entitled "How Do Anti-Psychotic Drugs Work?"

The M.I.T. Graduate Seminar, 20.77 Research Topics in the Neurosciences, continues to attract selected graduate students from M.I.T., Harvard University, and other Boston-area institutions. It is a one-term subject, given both in the fall and spring, and provides for graduate student participation in the scientific activities of N.R.P.

F. G. WORDEN

Northeast Radio Observatory Corporation (NEROC)

M.I.T. is a leading member of NEROC, a consortium of 13 educational and research institutions formed to promote radio and radar astronomy research. Member institutions are Boston University, Brandeis University, Brown University, Dartmouth College, Harvard University, Polytechnic Institute of Brooklyn, Smithsonian Astrophysical Observatory, State University of New York at Buffalo, State University of New York at Stony Brook, University of Massachusetts, University of New Hampshire, and Yale University. Through a NEROC-M.I.T. agreement, the administrative services of M.I.T. are used by NEROC in the conduct of its business.

The primary current responsibility of NEROC is the operation of the Haystack Observatory, located at the Millstone Hill Field Station of M.I.T., Westford, Massachusetts, about a 45-minute drive from Cambridge and a bit over one hour from Amherst, Massachusetts. The main instrument at the Observatory is a 120-foot diameter, paraboloidal reflector enclosed in a radome. Since 1964, this antenna has been used as a radio telescope covering the wavelength region from 21 centimeters down to about 1 centimeter. This year, however, we provided instrumentation which has permitted successful operations at a wavelength of 7 millimeters, corresponding to a frequency of 43 GHz. At this wavelength we confirmed detection of emission from molecules of silicon monoxide in several sources and have measured a beamwidth of 48 arc seconds, smaller than the 1 arc minute resolution of the human eye. These observations open a new region of the radio spectrum for future research at Haystack.

Radio astronomy operations at Haystack are supported primarily by the National Science Foundation (NSF). Over the past several years, the number of active observing programs under way at any time has ranged between 25 and 45, and during the course of a year, some 40 to 60 such programs have typically been completed. In 1974-75, over 20 students (about half of whom were doing thesis work based upon Haystack Observations) and 70 scientists, representing 25 institutions, were involved in investigations in which Haystack observations played a significant role. The large scientist participation resulted partly from Haystack's involvement in several very-long-baseline interferometer (VLBI) programs, which typically involve several observatories and a number of cooperating investigators.

Of 25 active observing projects in March, 1975, six involved VLBI, a technique based upon precise frequency/time standards which, using the telescopes of two or more observatories, makes possible interferometer baselines of thousands of kilometers. Haystack remains a leader in the development of VLBI techniques and equipment, having recently undertaken the development of a new, still wider bandwidth data recording and recovery technique (Mark III) which will greatly increase both sensitivity and resolution of VLBI systems.
These improvements are required to provide measurements of sufficient precision to permit interferometric determination of relative positions of widely separated antenna sites to the centimeter level of accuracy -- sufficient to permit the measurement of tectonic plate motions. Support for VLBI development is provided by the National Aeronautics and Space Administration (NASA), NSF, and the U.S. Geological Survey.

There were ten spectral line programs using the 13-millimeter (20-25 GHz) helium-cooled maser radiometer. This very popular capability, a mainstay over the past two years, will soon be rivaled by the newly added 7-millimeter system mentioned earlier. The line of silicone monoxide (SiO), discovered recently at this wavelength at the University of Texas, has sparked a new round of spectral line proposals for Haystack similar to that initiated by the discovery some years ago of water vapor and ammonia emission near 13 millimeters. The Haystack antenna is the largest telescope thus far to operate successfully at wavelengths as short as 7 millimeters.

The equipment for a 1,024-channel digital correlator spectrometer has been completed, and demonstrations with 512 of the channels in operation have been successful. Full operation is expected by September, 1975.

Under a project sponsored jointly by the Office of International Programs (of NSF) and the Conselho Nacional de Pesquisas (CNPq-Brazil), Haystack has completed a 13-millimeter maser and other equipment needed to instrument the Itapetinga Observatory of Mackenzie University, Sao Paulo, Brazil, for observations at this wavelength. This will permit extension to the southern sky of water vapor, ammonia, methanol, and other spectral line investigations. It will also make possible VLBI measurements on a unique north-south baseline between Haystack and Itapetinga.

Analysis and interpretation of the large body of lunar reflectivity and topography data accumulated with the Haystack Planetary Radar has continued under a subcontract from the Jet Propulsion Laboratory (JPL). In a collaborative effort, JPL, Haystack, and other lunar workers are comparatively interpreting IR, optical, radar, and, in some cases, directly-gathered Apollo data in order to gain a better understanding of the lunar surface.

The Haystack radar system continues to provide M.I.T. Lincoln Laboratory with observations of distant satellites beyond the range of most other radars. Haystack is also assisting Lincoln in the development of a new capability for high-resolution radar imaging of satellites at ranges out to synchronous altitude (40,000 kilometers). This new radar should be operating at Haystack by late 1976. Requirements for antenna time will be about 1,000 hours per year, and Lincoln Laboratory will provide the needed funding.

NEROC has before the NSF a proposal for improvements to the telescope reflector surface and the radome which would substantially improve the efficiency of the telescope at wavelengths of 7 millimeters and even shorter. New maser-based radiometers have also been proposed to exploit the short wavelength performance of the antenna. If these projects can be carried out, Haystack will remain of great interest to radio astronomers for a number of years to come.

The development of Haystack was first formally proposed by M.I.T. Lincoln Laboratory early in 1958, soon after the Millstone Radar Facility began operations, as a significant next step in the development of the technology of high-performance microwave systems. Its design, originally centered around the requirements of a high-performance ground terminal for satellite communication research, provided also for use as a high-resolution
radio telescope and a very-long-range measurements radar. These latter roles assumed increasing importance as advances in space technology shifted more of the elements of the typical communications link into the satellite itself, reducing the need for large, sophisticated ground terminals. Today, at a time of few new additions to the U.S. roster of major astronomy instruments, Haystack Observatory is an important scientific resource, comprising an advance computer-centered radio telescope which can operate effectively from 1,300 MHz to beyond 43,000 MHz.

The Northeast Radio Observatory Corporation was organized in 1967 to design and build a very large (440-foot diameter), fully steerable radio/radar antenna as a regional facility for the Northeast. With substantial support from the NSF, it developed a unique design for an antenna enclosed in a radome. A proposal to build this new instrument at a cost of just under $40 million was submitted to the NSF in June, 1970, just when limitations in funding led to the postponement of many capital projects. During this period, faculty from member institutions of NEROC, at the invitation of M.I.T. Lincoln Laboratory, had begun using the Haystack antenna for their own research. In 1969, NEROC was given part-time access to the Haystack facility, and in 1970, NEROC actually began operating Haystack as a regional university observatory. Haystack is available for research observations essentially on a 24-hour per day, 7-day per week basis, except for reasonable periods for maintenance and improvements. Research proposals may be submitted by any scientist, and allotment of time is on a basis of scientific merit and availability of suitable instrumentation.

PAUL B. SEBRING

Operations Research Center

The Operations Research Center conducts interdepartmental academic and research programs in operations research. The academic staff of the Center is drawn from many departments, including the Sloan School of Management, the Departments of Urban Studies and Planning, Electrical Engineering and Computer Science, Aeronautics and Astronautics, Mathematics, Civil Engineering, and Ocean Engineering. At present, about 20 students are in the operations research doctoral program, and a comparable number are in the master's program. Most of them come to M.I.T. specifically to study operations research, although some learn about the field through seminars, subjects, and discussions with faculty here.

During the past year, the academic staff and associated faculty of the Center have engaged in a wide range of research activities. A common thrust that connects much of the work is the use of the major operations research methodologies, especially mathematical optimization, decision analysis, and probabilistic models. Staff research has encompassed both new methodology and applications.

Among applications projects the largest single effort is the Innovative Resource Planning Project sponsored by the National Science Foundation (NSF). This work concerns urban emergency services, particularly police and medical care. One especially useful outcome has been the so-called "hypercube model," which assists urban administrators in allocating emergency vehicles or other response units to geographical areas. The model already has gained acceptance in a number of U.S. and Canadian cities. In another part of the project, a statistical analysis of urban homicide has attracted widespread attention, albeit because of its rather distressing conclusion that in certain cities and population groups the probability of death by homicide is remarkably high.
Another major applications project deals with multilevel logistical systems. Substantial progress has been made in finding effective ways to accomplish the partition, linkage, aggregation, and disaggregation of decision processes in large scale production-distribution systems.

Blood donor motivation and recruitment has been the subject of a further study, and yet another has considered problems in state government. In the latter, an on-line budget tracking system has been developed for a fiscal analysis group within the Massachusetts state government. Students and staff of the Center have conducted research in a variety of further applications, including housing, marketing, transportation, insurance, and energy.

Methodological research also has received continued strong attention. Mathematical programming is a particular speciality of several staff members. This year's developments included new work on the synthesis of mathematical programming duality theory with integer programming and combinatorial optimization. New methods have emerged that are very effective computationally and also offer structural insights that facilitate sensitivity analyses. Another rapidly expanding theoretical area has been the use of branch and bound methods to eliminate states in dynamic programming problems. This has permitted significant reduction in computation times and memory requirements. Finally, new work in network optimization and fractional programs emerged during the year. Other theoretical work by students and staff has focused on decision analysis, utility theory, and robust nonlinear estimation. More detail on these studies is available in the Center's Annual Report and reports of specific projects.

Support for the Center's research during the past year has come from NSF, the Public Health Service, the Office of Naval Research, the Army Research Office-Durham, and the Commonwealth of Massachusetts.

JOHN D. C. LITTLE

Project MAC

Project MAC is an interdepartmental laboratory for computer science. The laboratory includes four separable, but interacting, divisions staffed by approximately 240 people, including 30 faculty, 134 students, and 37 staff members. The four divisions and their respective leaders are Fundamental Studies, Professors Jack B. Dennis and Albert R. Meyer; Computer Systems Research, Professor Jerome H. Saltzer; Programming Technology, Albert Vezza; and Automatic Programming, Professor William A. Martin. The academic members of Project MAC are mostly from the Departments of Electrical Engineering and Computer Science, Mathematics, Architecture, and the Sloan School of Management.

Project MAC was started in 1963 with governmental (Advanced Research Projects Agency [ARPA]) support for research in computer science. The name MAC was derived from our early goal, Machine-Aided Cognition, and a tool for working toward that goal, Multiple-Access Computers. The major thrust of the early research at Project MAC was in pioneering work on time-sharing. Work on the Compatible Time-Sharing System (CTSS) was undertaken and completed at MAC with a clear demonstration of the feasibility and convenience of time-sharing. CTSS was the first major time-sharing system in operation.
Experience with that system led to the design and development of a more ambitious system, Multics, viewed as a public utility for dispensing information services. Multics gave rise to many pioneering ideas, such as an integrated file system, controlled access, segmentation, paging, virtual memory, use of high-level language to write operating systems, and multiprocessing. The system was made available to the entire M.I.T. community on a regular basis through M.I.T.'s Information Processing Center (I.P.C.). At present, over ten Multics sites are in operation serving a variety of users. In addition, some of the ideas that evolved with Multics are now incorporated in emerging computers.

Project MAC is now evolving into a computer science laboratory engaged in a broad spectrum of research activities. These activities are aimed at 1) reducing the cost and difficulty of programming, e.g., through use of computers that generate programs from higher-level specifications (Automatic Programming), through structured programming, and through the development of automated tools that enable and guide programmers; 2) implanting specific knowledge and expertise into computer programs for the purpose of dispersing services, e.g., in the mathematical assistant program MACSYMA, and in our clinical decision research, which strives to automate medical expertise in a narrow specialty; 3) improving computer systems through research in the economical description of complex systems and through the development of novel computer architecture structures; 4) exploring the use of computers, especially microcomputers, in automating the control of physical processes; and 5) conducting research on a variety of theoretical topics, e.g., limits on the complexity of performing certain computations.

The work of the Automatic Programming Division is progressing toward the development of techniques that will allow communication with computer systems to be made in the form of desires and goals, stated in a "natural" language, instead of the present method of specifying the solution to the problem in terms of algorithms. In cases where the system does not have a good method for dealing with problems, the user should be able to introduce, test, and verify algorithms which would be added to the system's repertoire of expertise. Communication difficulties with the computer would be eased because the computer system, with expert knowledge of the field under discussion, would exhibit common sense in communicating with the user. A first prototype automatic programming system, incorporating many new ideas, has been designed, and a good portion of it already has been implemented. The work on automatic programming derived much benefit from work on other systems such as the mathematical assistant MACSYMA, and the languages PLANNER, CONNIVER, and LISP, done at Project MAC and at the Artificial Intelligence Laboratory. The MACSYMA system, which has expert knowledge in specialized areas of mathematics, can perform such tasks as the factorization of polynomials or integration of algebraic expressions symbolically. It recently has become an important aid to research in plasma physics and will be offered as a service to several users under a consortium arrangement. Research is now under way with support from the National Institutes of Health (NIH) to use advanced computer technology in the formulation of better theories of the cognitive process in medicine. Such theories, in turn, will greatly speed the day when computer systems, expert in certain areas of medicine, can be introduced into the health care system. The ongoing work on clinical decision making draws on the work of the Automatic Programming Division and that of the Artificial Intelligence Laboratory. In the same division, the Engineering Robotics Group continued research in the automatic programming of microcomputers for the control of physical processes. One of the main objectives of this group is to translate through a computer programs written at a high-level language to programs suitable for microcomputers, subject to certain optimization criteria such as guaranteeing that real-time deadlines can be met by the translated program if they could be met by any program.
In the Programming Technology Division, Professor Barbara H. Liskov is directing the development of CLU, a programming language designed with new features to support the writing of well-structured programs. Programs prepared using CLU are expressed as collections of modules, each of which encapsulates an abstraction -- an operation or data type -- required for the problem to be solved. Professor Michael Hammer is engaged in the design and implementation of very high-level problem oriented programming languages. Optimization techniques, whereby implementation of very high-level programming languages can achieve satisfactory performance levels, have been developed. Principal among these is the idea of self-organizing data structures, whereby the system chooses its own representation for the data, based on its experience as to how the data is used. Mr. Vezza is directing the Dynamic Modeling System (DMS) development and a new effort in the application of expert knowledge-based systems to pattern matching and signal filtering. The Dynamic Modeling System is a developmental system whereby new and novel tools are provided to automate and systematize the human programmer's task of program composition, documentation, debugging, and maintenance. Notable among these tools is a program that is similar to the first phase of a compiler which reads programs and generates abstracts of programs which are later augmented by the programmer.

The Computer Systems Research Division is participating in two major projects, Project Guardian and the National Software Works (NSW). Project Guardian is a United States Air Force program to design and implement a computer operating system with certifiable provisions for security of information. The Computer Systems Research Division is performing the engineering research part of the program: development of simple, easy-to-certify structures for the internal organization of the operating system, and identification of the essential semantics of information sharing. The primary attention so far has been in the file storage and information access areas of the system, since those have been historically the least methodical areas of the computer system design. The goal of these tasks is an operating system smaller, simpler, and easier to understand than contemporary computer systems, without loss of function or performance.

In the Fundamental Studies Division, the Theory of Computation Group has concentrated on improving known algorithms for particular concrete computations and on developing new techniques for proving lower bounds on the computational resources required for various problems. Much of the effort towards deriving lower bounds has been directed towards the circuit or formula complexity of various functions with the objective of eventually using these techniques to derive lower bounds on the time required. Professors Meyer, Michael J. Fischer, and Visiting Scientist Michael S. Paterson have derived nonlinear lower bounds on the formula size of various symmetric functions. Professor Ronald L. Rivest has proved a general lower bound on the complexity of various graph algorithms in collaboration with Dr. Jean E. Vuillemin of the Institut de Recerches d'Informatique et D'Automatique (IRIA), France. Professors Meyer and Vaughan R. Pratt also have derived relationships between the sizes of formulae using a variety of operator bases. Other problems have been studied concerning the relative power of various computational devices. In the Computation Structures Group, Professor Dennis has led the development of several proposed central processor architectures using data flow program representations which are especially suited to highly parallel execution. These processors have the form of independent units that communicate only through asynchronous transmission of information packets -- an architectural concept we have found also attractive for structuring large memory systems to achieve high throughput by the concurrent processing of many transactions. Professor Suhas S. Patil and his colleagues have developed improved techniques for the analysis and synthesis of asynchronous systems. Petri Nets, an important tool for the study of concurrency, have been related to interesting problems in formal language theory, and several notable open questions have been settled by the work of Michel Hack.
During the period of this report, visitors to Project MAC included: Professor Uwe Pape of Technische Universität Berlin, Germany; Dr. William B. Schwartz of Tufts University; Nathaniel Rochester of International Business Machines, Inc.; Tadatoshi Minamikawa of Toshiba Electric Company, Japan; Professor Arnold Schönhage of the University of Tübingen, Germany; Professor Joseph E. Stoy of Oxford University, England; Professor Eliz Wada of the University of Tokyo, Japan; Knut Nordbye of A/S Norske Data - Elektronikk, Norway; Dr. Giulia Galbiati of the University of Pisa, Italy; Professor Michael Paterson of Cambridge University, England; Professor Herbert Weber of Technische Universität Berlin, Germany; Professor H. J. Stoss of the University of Konstanz, Germany; and Dr. Stephen Pauker of the New England Medical Center Hospital.

MICHAE L L. DERTOUZOS
JOEL MOSES

R.O.T.C. Programs

The attention of the faculty R.O.T.C. Committee during the past year focused on the problem of maintaining the three R.O.T.C. service options at the Institute. Two of the three units at the Institute, the Air Force and the Army, are experiencing difficulty in meeting their nationally established officer procurement requirements. If this situation persists, there is a possibility that the units may be deactivated. Since we believe it important for M.I.T. students and the services that the units be maintained at the Institute, we have been exploring ways, consistent with Institute policies, for keeping the units viable.

The Air Force R.O.T.C. presented the most immediate problem. Because of a declining need for new officers and a tight budgetary situation, the Air Force is currently reducing the number of A.F.R.O.T.C. units. The unit officer procurement quotas are extraordinarily tight. Our unit, for example, has a quota for the coming year, measured at the junior class, of a minimum of 17 cadets and a maximum of 18 cadets. Given the current low sophomore enrollments in A.F.R.O.T.C. at the Institute, it will be impossible for the local unit to meet its minimum quota. Since the Air Force's tolerance for deviant schools, such as our own, which teach an alternative curriculum is not particularly high, we felt the local situation was especially precarious. Professors Kenneth R. Wadleigh and Harvey M. Sapolsky visited A.F.R.O.T.C. headquarters at Maxwell Air Force Base in April to discuss our unit's status. In May, General James R. Brackel, the newly appointed head of Air Force R.O.T.C. visited M.I.T. to meet with President Jerome B. Wiesner, Professor Walter A. Rosenblith, and other Institute officials. Based on these and other discussions, it appeared that the most effective procedure to maintain the unit was to arrange a cross enrollment agreement for Air Force R.O.T.C. with another university. Such an agreement has been established with Northeastern University. Qualified Northeastern students will enroll in our Air Force R.O.T.C. detachment to take the standard Air Force R.O.T.C. curriculum and to be counted as part of the unit's quota. Because the Northeastern students will be taking the Standard Air Force program, they will not need to take any M.I.T. subjects or be formally enrolled at the Institute. An exchange of letters between the Provost and President Asa Knowles of Northeastern confirmed the arrangement.

The status of Army R.O.T.C. at the Institute, though not immediately pressing, is also precarious. Unlike the Air Force, the Army is short of junior grade officers, but like the Air Force, it cannot afford to maintain unproductive units. Our Army R.O.T.C. unit enrollments, though improving, are significantly below the national standard. A cross enrollment arrangement with Northeastern similar to the one worked out for the Air Force
is not possible in the case of the Army because Northeastern has its own Army R.O.T.C. unit. We are exploring the possibility of cross enrollment arrangements with other universities.

The Naval R.O.T.C. unit, fortunately, is in a relatively secure position. It has a very large entering class and is not being pressed to meet a specific quota. Its favorable situation is in part attributable to the unit's unique status in Naval R.O.T.C., as it is an exclusively engineering duty detachment. Other factors working in the unit's favor are the Navy's large scholarship program and the Navy's close affiliation with the Institute through the 13A program.

R.O.T.C. nationally is in a period of transition. Dissipating is the student and faculty hostility generated toward R.O.T.C. by the war in Vietnam and the service's needs for large numbers of new officers. Approaching rapidly is a stability in officer procurement requirements that will be effectively supported through Congressionally established scholarship programs. The Committee hopes that the steps available to us will preserve our units during this period of transition.

The reports from the individual R.O.T.C. commanders follow.

U. S. Army R. O. T. C.

Forty-eight students were enrolled in the Military Science Program at the completion of academic year 1974-75: 13 were freshmen, ten sophomores, 16 juniors, and nine seniors. Of this total enrollment at M.I.T., 43 are on Army scholarships (40 have four-year scholarships, one three-year award, and two two-year awards). For 1975-76, scholarship prospects appear even better. Advance information indicates that at least 18 freshmen will be entering M.I.T. with four-year Army scholarships. Based on an active survey of incoming freshmen, the interest in R.O.T.C. activities is higher than last year. Indications are that there will be an increased enrollment of nonscholarship students. During 1974-75, eight cadets received commissions. All received their first choice of military branch, with one selecting Ordnance, one Adjutant General, one Corps of Engineers, one Medical Service Corps; the remainder are unassigned pending completion of their graduate studies. Of those commissioned, two received regular Army commissions, and the remainder received Reserve commissions. Two of the commissionees have been assigned to four years active duty, one has been assigned three months active duty for training, and the remainder are pursuing graduate studies (among them are two studying medicine and one law). Efforts of the staff have been directed toward improving the quality of instruction, increasing enrollment, and insuring maximum accommodation of the cadets. To further cadet interest and to improve their tactical proficiency, a 24-hour training exercise was conducted at Fort Devens. Another exercise was scheduled but had to be cancelled due to heavy snows. Cadet reaction to field training programs was excellent. As part of wider Army orientation, cadets participated in a series of trips to military installations during the Independent Activities Period.

The M.I.T. chapter of the National Society of Pershing Rifles continued to show growth in its third year. Members of the chapter's Tactical Platoon spent 11 weekends on training exercises during the academic year. The Pershing Rifle Drill Team performed at a number of functions in the Boston area, including Veterans Day, Patriots Day, and other parades and ceremonies. The Rifle Team took part in many postal and shoulder-to-shoulder matches. One M.I.T. cadet attended and completed the basic airborne course. Two cadets partici-
participated in the Army Orientation Training Program (AOT) during summer, 1974. (The AOT program allows cadets to serve as junior officers with an active duty unit for a period of two weeks. The M.I.T. cadets trained with units at Fort Bragg, North Carolina.) Both the airborne training and the AOT were well received by the cadets. During the 1975 Summer Session, for the first time in M.I.T.'s history, Army R.O.T.C. subjects will be included in the program.

Five faculty members (two officers and three noncommissioned officers) and 12 cadets are participating in Advance Camp activities at Fort Bragg; during July they will be visited by M.I.T. representatives Dr. Barbara S. Nelson and the Professor of Military Science.

There have been a number of changes in the military staff. Departures through July, 1975, include Lieutenant Commander Francis W. Creighton, Major James H. Greeson, Staff Sergeant Peter P. DeSimone. Replacement personnel already assigned include Captain Richard L. Murphy and Staff Sergeant Eugene F. Bragiel.

U. S. N a v y R. O. T. C.

Fifty-one students were enrolled in the Naval Science Program at the end of 1974-75. The breakdown by class is as follows:

<table>
<thead>
<tr>
<th>Class</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seniors</td>
<td>3</td>
</tr>
<tr>
<td>Juniors</td>
<td>8</td>
</tr>
<tr>
<td>Sophomores</td>
<td>17</td>
</tr>
<tr>
<td>Freshmen</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
</tr>
</tbody>
</table>

As is evident from the above enrollment figures, the bulk of the N.R.O.T.C. population is in the bottom two classes. This is a direct result of the scholarship program instituted on this campus three years ago. The continued success of the program depends upon a substantial input of scholarship selectees acceptable to M.I.T. each year. Initial indications are that 36 scholarship students will be entering the freshman N.R.O.T.C. class next fall. It is expected that this number will be supplemented by a much smaller number of nonscholarship students. Also five prospective juniors, including one woman, have opted to attend the Naval Science Institute at Newport, Rhode Island, and will join the junior class in September upon successful completion of that program. We expect this input to be of continuing benefit in offsetting any student attrition that may occur in the first two years of the N.R.O.T.C. program. It is heartening that the enthusiasm toward the Unit has increased so noticeably, and it is expected that the goal of a strong, viable, self-sustaining program motivated by the active interest of students will be realized shortly.

The Naval Science curriculum continued to be well received by the midshipmen, as well as by other participating M.I.T. students. Particularly successful were seminars offered in conjunction with the Departments of Mechanical Engineering and Ocean Engineering. Continued effort is being expended to improve subject content, eliminate overlap, and better meet the subject requirements of both the Navy and the sponsoring departments. Field trips taken in conjunction with these subjects have proven beneficial in showing the applicability of curriculum content to operating ships of a variety of types.
Three new Technical Instructors have been nominated to replace Lieutenants Mark J. Ryan and Robert J. Leonard for next year. These replacements all bring excellent academic and service records to their new billets. They are Lieutenant John D. Urmston, Jr., Lieutenant Junior Grade William V. Moody, and Lieutenant Paul R. Brown.

U. S. Air Force R. O. T. C.

As academic year 1974-75 ended, the Air Force R.O.T.C. program had 31 cadets enrolled, distributed as follows:

<table>
<thead>
<tr>
<th>Course</th>
<th>Freshman</th>
<th>Sophomore</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Military Course</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Professional Officer Course</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

Seven of the 31 cadets are on full scholarship, and 11 are in the process of applying for three- or two-year scholarships. The freshman class includes the first woman, from Wellesley College. The senior class includes the first two women commissionees in the history of Air Force R.O.T.C. at M.I.T.

Throughout the academic year, considerable effort was expended to solve this detachment’s low enrollment problem. This effort culminated in a letter in January, 1975, from Chancellor Paul E. Gray to General White which advised the Commandant that M.I.T. was willing to accept cross-enrolled students into the Air Force R.O.T.C. unit at M.I.T. to the extent necessary to maintain the unit in a viable status. As a consequence of this action, the unit was continued in a probationary status for an additional year to allow time to conclude the necessary arrangements. Harvard University and Northeastern University were chosen as possible partners for limited consortium agreements. The proposed arrangement with Harvard has not yet materialized. Discussions with Northeastern culminated in an exchange of letters which was concluded in June, 1975, and which paved the way for qualified Northeastern University students to enter the Air Force R.O.T.C. program at M.I.T. Although the agreement came too late to achieve viability this fall, it appears reasonable that the Air Force unit will be viable in one more year.

A recent change in Air Force scholarship policy will assist in converting this hope to reality. For the first time, the Air Force is now offering four-year scholarships in the scientific/technological specialties. This year those scholarships are being offered to qualified high school seniors who applied for flying scholarships but who could not physically qualify for flying training. Next year the scholarships will be available on a nationwide competitive basis. This will be a great help to us since those students who qualify for admission to M.I.T. naturally fare well in the scholarship competition. Positive evidence of this is our forecast of 16 four-year scholarships for this fall, ten of which are expected to be in the scientific/technological specialty. Last year we received only one four-year scholarship.

Our curriculum was expanded this year by the addition of 16.83J/AS22J An Introduction to Aerospace Technology, which was included as the sophomore alternate curriculum subject. This was a successful joint effort with Professor Covert of the Department of Aeronautics and Astronautics.
The Commandant of the Air Force R.O.T.C., Brigadier General White, was replaced by Brigadier General Brickel. General Brickel visited M.I.T. in May, 1975 to discuss detachment status with M.I.T. officials. His decision to allow the detachment to teach the standard Air Force curriculum to Northeastern students eliminated the remaining barriers to successful completion of the limited consortium agreement.

During this academic year, several changes of personnel were accomplished. Lieutenant Colonel Larry Schwartzman accepted command of the detachment from Lieutenant Colonel Victor B. Goodrich in July, 1974. Captain Donna M. Kuha left the service in May and was replaced by Major Donald T. Carlson. Captain Randal Carlson is scheduled to arrive at the detachment in late July to assume Major Carlson's former duties. Staff Sergeant Elmer F. Sterling received orders to transfer to Italy by early August; he is scheduled to be replaced by Staff Sergeant Stephen R. Hartford early in July.

We look forward to the next academic year with a new sense of optimism.

HARVEY M. SAPOLSKY

Sea Grant Program

For the M.I.T. Sea Grant Program, academic year 1974-75 was highlighted by strong and significant projects in marine-related research, education, and advisory services. Program goals continued to reflect the Institute's philosophy of bringing engineering and technological disciplines to bear on the balanced use of ocean and coastal resources.

This was a fiscally difficult year for the National Sea Grant Program, which is organized within the National Oceanic and Atmospheric Administration, U.S. Department of Commerce. In spite of diminished funding available to the Office of Sea Grant, M.I.T.'s Program was given a generous vote of confidence through a 17 percent increase over 1973-74 in the size of its Federal grant, to $710,000. Matching funds, making up well over the required one-third of the total Program funding of $1,253,200, came from such diverse sources as the Henry L. and Grace Doherty Charitable Foundation, Inc., Harvard University Law School, the University of Massachusetts, Maine Maritime Academy, Boston Edison Company, the Welding Research Council, M.I.T., and other industries and organizations.

Program leadership continued this past year under Professor Ira Dyer, Director of the Sea Grant Program and Head of the Department of Ocean Engineering, and Dean Alfred A. H. Keil, Chairman of both the Sea Grant Policy Committee and the Sea Grant Faculty Council. Dean A. Horn, Executive Officer; Ernst R. Pariser, Advisory Services Officer and Senior Research Scientist in the Department of Nutrition and Food Science; and James E. Grayson, Administrative Officer, led an effective and dedicated staff in daily program operations.

With the assumption on August 1, 1974, of responsibility for the Institute's research vessel, the R.R. Shrock, the Sea Grant Program's role as the focus for marine-related studies at M.I.T. was augmented. Arthur B. Clifton, Sea Grant's Marine Liaison Officer, is in charge of the operation, scheduling, and maintenance of the R.R. Shrock; he is assisted by Rodney Swift, captain of the vessel. On June 1, 1975, the R.R. Shrock was moved to a new, permanent mooring at the New England Aquarium on Boston's Central Wharf.

The Research Vessel Management Committee, chaired jointly by Mr. Horn and Professor Bryan R. Pearce of the Department of Civil Engineering, developed the management policy
for M.I.T. research vessels. During the past year, the Committee completed arrangements, through the Oceanographer of the Navy, for the loan to M.I.T. of a U.S. Army T-Boat as a larger and more seaworthy replacement for the R.R. Shrock. Professor Kevin J. O'Toole (Captain, U.S. Navy) of the Department of Ocean Engineering supervised three graduate students as a conversion design team to plan conversion of the T-Boat's accommodations and equipment to meet Institute needs for a full-fledged research ship.

**Advisory Services**

With well established research and education components contributing to the wise use of the oceans and coasts, the M.I.T. Sea Grant Program saw major growth this year in its advisory services to Massachusetts, New England, and the nation. Advisory Services development continued in two primary directions: assistance to individuals, local and regional government, organizations, and institutions whose vocations or interests are served by the seas; and assistance to industry in the application of new technologies to business opportunities in the oceans.

Sea Grant Advisory Services enjoyed continued and expanded success with local and regional users during the past year. Serving state government, Professor Judith T. Kildow of the Department of Ocean Engineering was the Sea Grant Program's representative on the Governor's Task Force on Coastal Resources, a citizens' group appointed to assist the Commonwealth's Office of Coastal Zone Management in policy matters.

Sea Grant Advisory Services presented a number of well-attended symposia during the past year. The Third Annual Sea Grant Lecture featured Dr. Robert A. Frosch, Assistant Executive Director of the United Nations Environment Programme, speaking on "The Oceans: Planetary Engineering and International Management," with companion papers by Professor Kildow and Professor Richard R. Baxter of Harvard University Law School. In fall, 1974, Sea Grant cosponsored with the New England Aquarium a series of five lectures supported by the Lowell Foundation on "The New England Coastal Zone: Planning and Preservation."

November's First International Conference on Toxic Dinoflagellate Blooms, held jointly by the Massachusetts Science and Technology Foundation and the M.I.T. Sea Grant Program, provided presentations of current research on oceanographic conditions associated with the poisonous algal blooms, including red tide, on the organisms' biology, toxin chemistry, and pharmacology, and on management of paralytic shellfish poisoning. In April, John Hutton, Development Officer of the North East Scotland Development Authority, gave the first in a planned Sea Grant series of lectures showing regional perspectives on offshore oil.

Other Sea Grant Advisory Services projects were carried out with local organizations in a variety of activities useful to marine and coastal interests in the Commonwealth. Working with the University of Massachusetts Aquacultural Engineering Laboratory in Wareham, Sea Grant staff provided expert assistance to shellfishermen, aquacultural concerns, and local seacoast towns. A film on last year's development of low cost dams for alewife runs in shallow coastal streams was completed; the film has been used to explain the concept to local officials and conservation groups. In April, 1975, a joint, year-long study began on the effectiveness of a new, vigorous strain of American beach grass for stabilizing a washed-over section of Nauset Beach on Cape Cod. The Sea Grant Program's partner in this endeavor is the Massachusetts Beach Buggy Association.
The Sea Grant Program has participated actively with other New England Sea Grant institutions in the founding of the New England Marine Advisory Service (NEMAS), headquartered in Durham, New Hampshire. NEMAS will respond to regional needs for information pertinent to ocean and coastal zone activities, and the Marine Resources Information Center, following on its history of reference and research services, will become an important part of this regional network. Mr. Pariser is a member and vice chairman of the NEMAS Board of Directors.

To bring about closer collaboration with industries interested in the marine field, Sea Grant has established a Marine Industry Advisory Service (MIDAS). MIDAS provides for two types of partnership between the M.I.T. Sea Grant Program and member companies: the M.I.T./Marine Industry Collegium, which will help to keep participating firms abreast of economically significant opportunities for new enterprise in the seas; and the Marine Industries Business Strategy Program, an intensive, in-depth study of a selected marine resource, product, or service that is of particular interest to and of high economic potential for industry. MIDAS builds upon the Institute's tradition of working ties with business and industry and seeks to encourage a mutually beneficial partnership between the M.I.T. Sea Grant Program and MIDAS members, geared to the identification and undertaking of marine business opportunities.

**Academic Program**

The M.I.T. Sea Grant Program's projects in marine education maintained strength in two directions: expanding the Institute's ocean-oriented curriculum, and providing opportunities for the practical application of students' classroom knowledge to marine and coastal zone problems.

A significant addition to departmental offerings during academic year 1974-75 was a new graduate-level subject on coastal zone management policy and planning and the use and conservation of coastal resources. Also under partial Sea Grant support, Professor J. Daniel Nyhart, of the Sloan School of Management, continued his joint experimental program on the interrelationships between ocean engineering and law, with faculty from the Department of Ocean Engineering and the Harvard University Law School.

During summer, 1974, the Sea Grant Program cooperated with the Summer Session Office in offering to practicing professionals from industry and government four week-long subjects on analysis and design of transportation systems, ship structural analysis and design, strategic planning in the energy sector, and ocean resources management.

A major focus of Sea Grant efforts in marine-related education is the involvement of students in practical, interdisciplinary studies of ocean engineering and coastal zone questions. Undergraduate and graduate students in the summer laboratory led by Professor A. Douglas Carmichael of the Department of Ocean Engineering, among many other projects, continued development work on a free-swimming underwater robot that can be programmed to do oceanographic research. During the 1975 spring term, Professor William W. Seifert of the Department of Civil Engineering guided student participants in his Interdisciplinary Systems Design subject through a successful coastal and regional planning study of four Massachusetts South Shore towns, Hull, Cohasset, Hingham, and Scituate. Study results were presented in May, 1975, to the towns' residents at a meeting held by the South Shore Chamber of Commerce.
Research projects supported by the M.I.T. Sea Grant Program have as their objectives increasing society's wise use of ocean and coastal resources and expanding human horizons in the seas. During academic year 1974-75, Sea Grant's sponsored research again brought together many Institute disciplines and departments to solve marine and coastal problems that hinder the attainment of these objectives.

Understanding and improving coastal water quality has been the goal of several long-term Sea Grant projects. Professor Jerome J. Connor, Jr., of the Department of Civil Engineering, has carried on the leadership of Sea Grant's Massachusetts Bay research, begun by Professor Erik L. Møller-Christensen, of the Department of Meteorology, and the late Institute Professor Emeritus Arthur T. Ippen. Mathematical models developed to predict the hydrodynamics and pollutant dispersion processes in the Bay and in other offshore waters have been used during the past year for studying the thermal outfall at the Pilgrim Nuclear Power Plant in Plymouth, Massachusetts; for performing preliminary site evaluations for a potential power plant on Narragansett Bay in Rhode Island; and for making storm surge predictions for the Atlantic Generating Station off the New Jersey coast. Professor John W. Devanney III, of the Department of Ocean Engineering, continued his research on the economic and environmental impacts of outer continental shelf petroleum with a year-long study on the movement of oil spills on the ocean's surface.

Professor François M. M. Morel, Sea Grant's first Henry L. Doherty Assistant Professor of Ocean Utilization, is pursuing his research on the development of a biochemical or bioenergetic model for coastal waters that will match current hydrodynamic and chemical models to predict nutrient concentrations, biomass, pH, or dissolved oxygen. An exploratory Sea Grant project led by Professor Emeritus John G. Trump, of the Department of Electrical Engineering and Computer Sciences, on the use of high-energy electrons as an effective and economical method for treating waste water and sludge, was given major support for academic years 1974-76 through the National Science Foundation's Research Applied to National Needs program. This will enable Professor Trump's research group to complete the laboratory work and to build and operate a full-scale experimental facility at the Metropolitan District Commission's Deer Island Sewage Treatment Plant in Boston Harbor.

Understanding economic and political constraints on society's use of the seas is another goal for the M.I.T. Sea Grant Program. Under Sea Grant sponsorship, Professor Henry S. Marcus, of the Department of Ocean Engineering, completed research on the potential of fishermen's cooperatives for improving the economic outlook of New England's fishing industry. Professor Marcus concluded that a federation of cooperatives could provide more bargaining power in the marketplace for fishermen and could aid in providing a reliable supply of fish to meet a given demand.

Sea Grant strives to augment society's beneficial use of living marine resources. The Sea Grant-sponsored investigation on the use of squid for processed food products, under the direction of Professor Samuel A. Goldblith, Underwood-Prescott Professor in the Department of Nutrition and Food Science and Director of the Industrial Liaison Office, completed analyses showing that, at present, exporting squid to Mediterranean and Asiatic markets has greater potential for economic return than local marketing. Professor James M. Flink and graduate student Leslie N. Kahn, of the Department of Nutrition and Food Science, have determined the product and process characteristics and functional properties of squid protein concentrates, have developed an improved process for extracting protein
from squid muscle, and have studied questions of the concentrates' nonprotein nitrogen content and off-odors that may appear during storage. Professor Goldblith, assisted by Mr. Pariser, also led a new project begun this year on the content, composition, and conversion of physiologically important lipids in raw and processed fish and shellfish, information which should prove valuable to the fields of medicine and nutrition.

Professor Benjamin L. Averbach, of the Department of Materials Science and Engineering, pursued research on the structure of chitosan, the potentially useful material derived from the chitin contained in crustacean shells. Clear, flexible films have been cast of chitosan obtained from several species of shellfish, and studies are under way on the properties of the chitosan and the strength of the films. In mariculture, Professors Seifert and John W. Zahradnik, of the University of Massachusetts, have developed and operated a small-scale system to demonstrate the indirect use of thermal effluents from power plants for raising oysters, and have performed a parametric economic analysis of a finishing plant for cultivated oysters.

A particular strength of the M.I.T. Sea Grant Program has been its research projects that explore the application of technologies in the marine field. Seeking to improve an antiquated, dangerous piece of equipment used on New England's side trawling fishing boats, Professor Stephen P. Loutrel, of the Department of Mechanical Engineering, and graduate student John C. Wall designed and constructed a new hook-up block for the towed nets. The block has been tested safely on several working boats, and plans are being made to foster its distribution to the industry. Professor Chryssostomos Chryssostomidis, of the Department of Ocean Engineering, working on multipurpose off-shore platform design, completed pilot projects on the design of platforms for a nuclear power plant with a desalination facility and oil storage terminal. He also finished preliminary research on the engineering analysis needed in the design of offshore platforms.

In Sea Grant research aimed at improved methods and materials for ocean engineering, Professor Koichi Masubuchi, of the Department of Ocean Engineering, developed several new underwater welding and cutting techniques and is testing and refining a device for welding studs to plates underwater. Professor Frederick J. McGarry, of the Department of Materials Science and Engineering, completed his research on the fracture mechanics of rapid, catastrophic crack propagation in the fiberglass-reinforced plastic composites often used as boat hull materials. The project has advanced understanding of failure processes in fiberglass materials, information that could improve hull design, construction techniques, and fiberglass boat maintenance.

IRA DYER

Special Freshman Programs

In addition to the "regular" freshman program of required and elective subjects, two special programs exist in the freshman year—the Concourse Program and the Experimental Study Group (E.S.G.). Concourse and E.S.G. each accept between 20 and 50 freshman students. The programs offer a pattern of subjects, seminars, and tutorial classes which are distinct from the subject offerings in the regular program. Each originated as an experiment sponsored by the Committee on Educational Policy (C.E.P.). E.S.G. enrolled its first students in 1969, Concourse in 1971. In 1974-75, E.S.G. enrolled 35 freshmen, and Concourse enrolled 48. The programs continued under the sponsorship and educational overview of the C.E.P., with a special C.E.P. subcommittee as liaison. The chairman of this subcommittee for 1974-75 was Professor Robert G. Gallager.
In 1973, the C.E.P. extended the approved term of each program until 1976, with the provision that the programs would be subject to yearly review by the C.E.P. and with the implication that a final review would result in recommendations as to their possible continuation under more permanent administrative arrangements.

In its informal interim report for 1974-75, the C.E.P. subcommittee noted: "there appears to be a great deal of enthusiasm for the programs on the part of the faculty and staff, and the programs seem in good health." The subcommittee went on to comment: "Both programs provide an academically based community for a group of faculty and students, but Concourse has a more structured program than E.S.G., which is geared toward individualized learning.... Both programs seem to have evolved over the years toward a greater emphasis on fulfillment of the General Institute Requirements, and both programs seemed more regularized now than at their inception.... The staff in Concourse now tend to be associate and full professors, whereas the staff in E.S.G. consists primarily of younger faculty or instructors and upperclass tutors. This is to some extent a reversal of the patterns of several years previously.... A feature of both programs which received very favorable comment from the students was the opportunity to engage with faculty in the exploration of ideas, in contrast to the lecture style of education in which information is prepackaged and presented as a piece. It was noted also that the programs provide opportunities for faculty from different departments to work together, and that this contributes positively to the atmosphere of the academic community."

Looking ahead to a final C.E.P. report in 1976 and to a possible recommendation that the programs be continued on a regular basis, Concourse and E.S.G. have entered into provisional administrative associations with one or more of the Schools for the coming year. E.S.G. will be associated with the School of Science. The Dean of Science will take an administrative overview of the program, and the Science Council will, at its own request, become more closely acquainted with the program's operation. The Concourse program will be associated with the School of Humanities and Social Science and the School of Engineering. The Dean of Humanities and Social Science will take an administrative overview of the program with the Dean of Engineering serving as a joint sponsor. Professor Louis L. Bucciarelli will act as immediate liaison.

HARTLEY ROGERS, JR.

Summer Session

Special Programs

There were two contrasting developments in summer, 1974: the highest percentage of canceled programs ever, but yet the highest average registration per program presented since 1969. Of the 68 programs planned for the 1974 session, 14 had to be canceled because of projected low enrollments. There was a total registration of 1,946 in the 54 programs compared with a 1973 registration of 1,559 in 45 programs. The appeal of the summer series was quite selective. It was apparent that the vocationally-oriented type of program was most attractive.

The widespread interest in the programs is indicated by the following statistics on the composition of the 1974 registrant body: 57 percent were affiliated with industrial companies, 29 percent with governmental agencies, and 14 percent with educational and non-
profit institutions. Sixty-seven percent of the registrants came from east of the Mississippi River, 15 percent from the western portion of the United States, six percent from Canada, and 12 percent from outside North America. The only significant change from previous years is the increase in the number of registrants from foreign countries.

Regular Subjects

Graduate students comprise 85 percent of the student body in the summer. The 1974 registration of 2,153 students represents a small decrease from the 2,205 in 1973.

Conferences

About 250 people attended the Tenth Naval Hydrodynamics Symposium held in June, 1974, under the sponsorship of the Office of Naval Research. Professor Philip Mandel of the Department of Ocean Engineering was chairman. In addition, there were a variety of small conferences and special activities conducted by departments and centers.

JAMES M. AUSTIN

Teaching Intern Program

Academic year 1974-75 was the final year of the Teaching Intern Program, a project started in 1968 as a means for M.I.T. students to work in the Cambridge high schools and, through a credit seminar, Institute Seminar 211, to qualify for teacher certification in the Commonwealth of Massachusetts. From 1968 through 1975, a total of 277 students have taken Seminar 211 and have taught in either Rindge Technical High School or Cambridge High and Latin School. Of that number, many have sought and received teacher certification from the Commonwealth.

In 1970, a program of academic subjects was developed at M.I.T. which met the subject requirements for state certification in addition to the teaching program. These offerings were in the Departments of Psychology and Humanities, and, when taken in conjunction with the teaching seminar, provided the framework for subsequent certification. Subjects in psychology, philosophy, or in teaching methods in the curriculum at Wellesley College also could be used to meet certification requirements.

During the years in which the Teaching Intern Program functioned, it was administered from the Office of the Provost in tandem with the M.I.T.-Wellesley Upward Bound Program. From the outset, intellectual support for the program centered in a committee of faculty who from 1968 through 1972 oversaw the development of the program and assisted in the weekly seminars. From 1972 onward, John P. Terry supervised the program under the direction of Dr. Louis Menand III, Assistant to the Provost. Mr. Terry's close association with the Cambridge schools through his primary responsibility as Director of the Upward Bound Program was a significant factor in the smooth operation of the Teaching Intern Program. Mr. Terry was assisted by Michael A. Efron, one of the original staff members.
who worked to establish the teaching program in 1968. (See the Teaching Projects section of the Provost's report for the year 1971.)

In the past two years, the Commonwealth has undertaken a major review of teacher training programs within the state and indicated to M.I.T. that its present program, while satisfactory under the previous teacher training guidelines, would not be satisfactory under guidelines in preparation. With this in mind, we sought ways by which the Teaching Intern Program could be located in an academic environment within the Institute where it would be a vital project to faculty and one in which they would find an opportunity to participate. This search was not successful and with great reluctance, the program was terminated in June, 1975.

The brief history of the Teaching Intern Program indicates the difficulty of matching worthwhile educational endeavors with academic departments or disciplines when there is not a mutual attraction. The teacher program grew out of the urban concerns of the 1960s, but as the focus of faculty and student attention has altered, the support for such a program has declined. As of the writing of this report, the Institute has become associated with the East Boston High and Middle Schools under Federal court orders related to the desegregation of Boston schools. Within this association there may develop a need for a modified teaching intern program, in which case the experiences and insights gained from the Cambridge based Teaching Intern Program will be important.

LOUIS MENAND III

Technology and Culture Seminar

The Technology and Culture Seminar is a forum for confronting issues raised by science and technology, how they are used, the values they serve, the moral, social, political, and cultural problems which they affect. These are issues which not only transcend particular academic disciplines, but transcend at least a narrow definition of science: that is, they involve epistemological, human, political, ethical, and theological questions to which science has provided only partial answers; yet these are questions which set the context for scientific and technological decisions. The Seminar has tried to see that these questions and issues receive the disciplined analysis, study, and discussion which they require but do not always receive.

The Seminar is an evolving program of interdisciplinary lectures and discussion groups. It is run by faculty, primarily for faculty, but also includes sessions open to students and the wider M.I.T. community. The Seminar emerged in 1971 out of the ministry of the Episcopal Chaplain, the support of the Episcopal Church of Massachusetts, the commitment and interest of a wide variety of faculty, and the continued support of the administration. The Seminar has grown with the help of a faculty steering committee appointed by the Provost and with financial support from the President, Provost, four of the Schools at M.I.T., interested foundations, and several agencies of the Episcopal Church.

For the past four years, the Technology and Culture Seminar has provided settings for lectures and discussions by distinguished M.I.T. faculty and visiting speakers. In 1971-72, a group of issues relating to science and technology were examined by six scholars: Philip Morrison, Everett Mendelsohn, Derek DeSola Price, Salvador Luria, Victor Weisskopf, and John Silber. In 1972-73, the tension between new perspectives on human nature (suggested by advances in science and technology) and older, more traditional perspectives were
explored by Leon Eisenberg, Ernst Mayr, Noam Chomsky, Lewis Mumford, Alasdair MacIntyre, and Huston Smith. In 1973-74, the seminar was concerned with three topics: aspects of the philosophy of science were discussed by Gian-Carlo Rota of M.I.T. and Marx Wartofsky of Boston University; the future of man and society was the subject of talks by Daniel Bell, Robert Heilbroner, Kenneth Boulding, and Alva Myrdal; and the responsibility of universities for the higher education of minority groups was clarified by John U. Monro and Kenneth B. Clark.

In 1974-75, with a faculty seminar on Merit and Equality in a Just Society, the Seminar took an important step in the direction of intensive interdisciplinary faculty study. The attempt to develop a consistent and continuous membership of the Seminar was only partly successful, but the quality of the lectures and discussions was excellent. The topic of discussion was the ways in which scientific data and argument can be used in economics, in education, and in medicine to justify policies which militate against equality and for the social control of people. The principal speakers were Stephan L. Chorover, Jerome Kagan, Robert Nozick, Frances Fox Piven, Lester Thurow, Phyllis Wallace, Herbert Gintis, Richard Lewontin, and Jonathan Beckwith. A full report on the Seminar, which includes the readings, lectures, and summaries of the discussion, is being developed and will be published in September, 1975.

In 1975-76, the Seminar will sponsor three programs: a subject (for credit) and a series of public lectures on Simone Weil (open to students and faculty from other colleges and universities as well as from M.I.T., and jointly sponsored by the Department of Humanities); a luncheon seminar for faculty and staff at M.I.T. on Technology, Merit, and Equality; and a weekly supper lecture and discussion series throughout the year, open to the entire M.I.T. community, on the evolving understanding of human nature in the Western tradition, with particular concern for the influence and contribution of science toward that understanding. This latter program will be called Humanitas: an Evolving Perspective, and will be led by Judith Wechsler, Associate Professor of the History of Art at M.I.T.

JOHN CROCKER

Upward Bound Program

The M.I.T. /Wellesley Upward Bound program is a coeducational, multiracial, multiethnic educational program for Cambridge high school aged youth. Now in its ninth year, the program serves 70 academically promising young men and women who have low achievement aspiration and who come from low income families. The goal of the program is to motivate these youths to attend college and to provide them additionally with the necessary academic and social skills needed to succeed in college. To a very large extent, the program is influenced by the research done by the social psychologist Kurt Lewin and his associates, particularly in the area of goal setting or "level of aspiration." The program has operated on the assumption that ego growth and academic performance are closely related, and has met with good success. A developing ego needs to experience success, and it will develop more strongly, in both a personal and social sense, in a warm and personal, but structured environment. This development can be manipulated through intervention outside of the family and the school.

Upward Bound represents such a controlled field intervention. It has established that the effects of failure can be reversed by presenting the young person with real success and that further success leads to an increase in the level of aspiration. In this process, the people around the students -- fellow students, teachers, and other program staff -- play
a crucial role because what students think they can do is dependent on what others think they can do. Consequently, the students’ perceptions of their abilities, and therefore what they will try to accomplish, is to a large extent determined by the program staff, who are often the first and only people to see real academic promise in the youngsters.

The Summer Program

The Summer Program, conducted in residence on the Wellesley College campus for six weeks, is designed to provide students with an intense academic and social experience. Classes are team taught by experienced Cambridge high school teachers, Wellesley College and M.I.T. students, and Upward Bound alumni now attending college. Upward Bound students take three classes, each of which meets for 50 minutes daily, five days per week during the summer program. Classes are small, so a seminar format is possible. Each student is required to take one math and one humanities course and to select a third course. Humanities offerings include reading and writing, black history, minority American history, teens and the law, drama, the urban scene, utopias, the American Indian, and the Fifties. Science courses include biology, chemistry, astronomy, and man and his environment. The mathematics program includes an enrichment section for students who are going to take algebra I or II, geometry, or math IV; a review section for students who have done poorly in algebra I or II, geometry, or math IV; as well as a computer math and a computer programming course in BASIC sponsored by International Business Machines (IBM). IBM’s sponsorship of these courses, the teachers, computer terminals, and couplers, follows several previous years of generous contributions supporting computer courses and of participation in our program.

The Academic Year

The academic year program, while ostensibly less intense and dramatic, has importance at least equal to that of the summer. Building on the motivation and enthusiasm developed over the summer, the academic year program is designed to help the student cope with the myriad academic, social, and family problems that confront him back in Cambridge. To achieve this, the following programs, staffed primarily by M.I.T. and Wellesley College undergraduates, have been developed and implemented.

Study Skills The M.I.T. Upward Bound offices are open four evenings a week from 7 to 9:30 p.m. for study. Students are encouraged to spend at least one evening per week at one of these study sessions. Each session is manned by a team of two leaders who are part-time staff and about four undergraduate volunteers. They work individually or in small groups with students on school related problems.

Tutoring Whenever requested or needed, tutors are assigned to individual students. Tutors are typically M.I.T. or Wellesley College undergraduates who arrange to meet on a mutually convenient and regular basis with the Upward Bound student and then report back to project staff.
The Saturday Program

The goal of the Saturday program is to furnish a miniature replication of the Wellesley summer experience. Students attend during the fall, winter, and spring on a regular basis on Saturdays for six hours.

The Saturday program includes an arts and crafts class, drama, and a math class, as well as the use of the pool and gym.

College Report

Of 21 graduating seniors in 1975, 20 have been placed, and one is taking a year off before entering college. Colleges which the students will attend include: Brandeis University Transitional Year Program; Brandeis University; Bridgewater State College; Emmanuel College (2); Florida A and M University; Franklin Pierce College; Macalester College; Massachusetts Institute of Technology; Simmons College; Springfield College (2); Syracuse University; Tufts University; University of Massachusetts, Amherst; University of Massachusetts, Boston (2); Worcester Polytechnic Institute; Chamberlayne Junior College; and Graham Junior College.

JOHN TERRY

Wellesley-M.I.T. Exchange Program

In 1974-75, the Wellesley-M.I.T. Exchange Program continued for the second year as part of the regular academic program of the Institute. It was a year that brought a number of changes to the pattern of cooperation between the two institutions. Heretofore, the Exchange has consisted almost entirely of cross-registration for subjects at one institution by students from the other. In 1974-75, direct faculty cooperation and interaction began to flourish. Beginnings were made in jointly developed curricula, a joint faculty appointment, and shared research facilities.

In quantitative terms, the most active part of the Exchange continued to be the student cross-registration, with the equivalent of approximately 25 percent of Wellesley students and ten percent of M.I.T. undergraduates taking advantage of educational opportunities at the other institution. There was a decrease from last year in the number of Wellesley subjects taken by M.I.T. students. One contributing factor was the new Institute Requirement in Humanities and Social Sciences.

For the first time, Wellesley offered a diverse program of activities during January, under the name Winter Term. This counterpart to M.I.T.'s Independent Activities Period was almost entirely student-initiated, and its more than 100 activities encompassed everything from a workshop in observational astronomy to an activity known as "Live in China." Through this program, a group of Wellesley and M.I.T. students, under the guidance of Professor Helen Lin, Chairman of Wellesley's Chinese Department, spent the month of January speaking Mandarin Chinese, learning the accompanying Chinese customs, and attending lectures on Chinese opera and history and workshops for Chinese cooking and painting.
In the spring term, Elizabeth Long, an instructor at Wellesley College, taught a section of a Wellesley subject on the M.I.T. campus. This course, Contemporary Women: Interdisciplinary Perspective, drew on several disciplines to aid students in orienting their thinking about the nature of women and their actual and possible positions in modern society. This subject was well received by the M.I.T. students who participated.

Discussion this year between members of the Wellesley Department of Geology and M.I.T.'s Department of Earth and Planetary Sciences have set in motion new patterns of cooperation. Wellesley's paleontology subjects and field trips will provide something for M.I.T. students not available on this campus, while advanced subjects (as in petrology) and access to M.I.T. research equipment fill what would otherwise be a void in the education of geology students at Wellesley.

The Department of Religion and Biblical Studies at Wellesley and the Department of Humanities at M.I.T. are cooperating in an attempt to make a joint faculty appointment in the area of Far Eastern religion.

This year, the Departments of Political Science at Wellesley and M.I.T. agreed to "share" four faculty members during the 1975-76 academic year in an effort to broaden the curricular opportunities available to students at the two institutions. Two M.I.T. subjects -- Ideology and Participation in Black American Politics, and Political Crisis in South Asia -- and two Wellesley courses -- Private Interests and Public Issues in American Politics, and Law and Social Change -- have been selected, and deliberate efforts will be made to enroll roughly equal numbers of M.I.T. and Wellesley students in each subject.

KENNETH HOFFMAN
For the School of Architecture and Planning, this year has been one of building on existing strengths and developing some important new ones. It has also been one of reaching out, of exploration beyond the boundaries of the School. Particularly important have been the several curriculum development efforts coupled with the strong commitment of both departments to examine the relationship between the professional education offered here and the professional practice which students enter when they leave the School.

The Departments of Architecture, Urban Studies and Planning (D. U. S. P.), and the Laboratory of Architecture and Planning continue to expand institutional relationships through joint appointments and joint subject offerings. In addition, a number of professors and practicing professionals from all over the world came to the School to give lectures, teach courses, and conduct symposia.

Faculty and staff members, particularly those in the Laboratory, devoted a significant amount of attention to developing and maintaining relationships with potential sources of funding. These efforts will accelerate as the School steps up its involvement in the M.I.T. Leadership Campaign.

Several activities have been initiated this year which will help to bring the School to a better understanding of and communication with the architecture and planning professions. These include a major study of architecture education and internship programs which allow students to earn credit for work performed in private offices and public agencies. In addition, numerous speakers, including faculty members, have presented facets of the working world to students in both departments. The departments continue to stress the value of community-related subject offerings ranging from the increased field orientation of many studios to the direct involvement of students in the community.

This has also been a year of transition for both departments in the School. Professor Langley Keyes gave energetic and capable direction to the Department of Urban Studies and Planning in his first year as Head of the Department. Associate Professor Lawrence Susskind, in his first year as Assistant Head, continued to carry the strong central role which he has filled so ably in the Department for the last several years.

In the Department of Architecture, Professor Donlyn Lyndon stepped aside as Department Head on June 30, 1975. Professor Nicolaas John Habraken, who was Professor of Architecture and Urban Design at the Technical University of Eindhoven, in the Netherlands, will be the new Department Head.

Professor Lyndon, in his eight years of leadership in the Department, developed it arts program into a major and exciting arts nucleus. As Chairman of the Faculty Arts Committee since 1972, he has provided leadership for the growth of the arts at M.I.T. and conducted important studies for the development of arts facilities as well. He also is involved in design consulting work with Lyndon Associates and Placemakers, Inc. Professor Lyndon will continue teaching in the architectural design program, and will devote more of his attention to the role of architecture and environmental art in shaping and enriching the public environment.
Incoming Department Head John Habraken made three two-week visits to the School this year, during which he familiarized himself with the Department and the Institute. He twice went to Washington, D.C. to discuss research opportunities in architecture with representatives from several Federal agencies. Anne Vernez-Moudon and Eric Dluhosch were appointed, respectively, Assistant Professor and Research Associate to work with Professor Habraken beginning in the 1975-76 academic year. The School is looking forward to the new perspectives which Professor Habraken's teaching, research, and administration will bring to the programs in Architecture.

Teaching Programs

In the Department of Architecture, students and faculty launched a major effort to revise and organize more clearly the offerings in architectural design and their relationships to other subjects. As the design studios occupy a central position in the curriculum of a majority of the students, student participation continues to be an integral part of this effort. Following up on discussions begun in the spring term, a curriculum development effort is under way this summer to revise the first year design studio.

The variety of subject offerings this year bears witness to the expanding concerns of the Department of Architecture. Offerings ranged from building process, materials, and technology, to computer use in design and the study of the architect as activist. This spring, for the first time in many years, one of the design studios -- on energy conservation -- was taught jointly by professors from Harvard University's Graduate School of Design and M.I.T.'s Department of Architecture, with enrollment from both schools.

The program for history, theory, and criticism of art, architecture, and urban form is preparing for the first year of the new Ph.D. program in Architecture, Art, and Environmental Studies in the Department of Architecture. The visual arts program continued to attract increasing numbers of students, both from the Department and from the rest of the Institute. The Creative Photography Laboratory, the Visible Language Workshop, and the Film Section offered beginning and advanced work in all aspects of publications, graphics, film, and photography, and allowed students the opportunity to present their work through posters and exhibitions designed for various groups at M.I.T.

The Department of Urban Studies and Planning (D.U.S.P.) devoted much energy this year to following through on the recommendations generated from last summer's study of the curriculum needs of the Department. "The Planning Process," a seminar which will be required for entering M.C.P. candidates, was revised and readied for the fall. Faculty and students have worked on the development and implementation of other required core subjects in urban economics, institutional analysis, and analytic methods for planners. Other subjects, such as health care planning, urban design, and environmental management were strengthened. The D.U.S.P. Undergraduate Program was revised to give students better guidelines for pursuing the different paths of specialization which were offered; and the undergraduate thesis has been broadened from traditional research to include an emphasis on policy analysis and problem solving.

The Special Program for Urban and Regional Studies of Developing Areas (SPURS) brought 14 Fellows to D.U.S.P. this year to study problems of urban and regional change. The Community Fellows Program (C.F.P.) had ten Fellows involved in study and research in areas relevant to the needs of minority communities. Formerly administered by the Office of the Provost, the C.F.P. is now officially part of the Department of Urban Studies and Planning. During the next year, it will be evaluated and redesigned for the fall of 1976, when the next group of Fellows will arrive.
Undergraduates in the School participated in the Institute's Undergraduate Research Program (UROP), which provides opportunities for students to work with faculty and staff members on research projects both on and off campus. Overall, 71 undergraduates in the Department of Architecture worked on 53 projects, and 41 undergraduates in D.U.S.P. worked on 17 different projects.

During the course of the year, approximately 65 percent of the students in D.U.S.P. worked with faculty members or with officials in various government agencies on community planning projects. The Minority Intern Program, sponsored by the U.S. Department of Housing and Urban Development, placed 20 minority M.C.P. candidates in part-time internship positions in the greater Boston area, and held a monthly seminar for the interns on various planning issues. In the Department of Architecture, the new Architecture Internship Program placed five design students in architecture firms for design studio credit, and the Architectural Assistance Program run by and for students, coordinated over 20 fieldwork and part-time job placements for architecture students.

To complement the School's term-long subjects, a large selection of "mini-subjects" was offered during the January Independent Activities Period (I.A.P.). More than 30 faculty members and students in the School gave classes on such topics as photographic imagery, filmmaking, grantsmanship, and land use models.

Reinforcing the links between the School's two Departments and between the School and other parts of the Institute, joint subjects continue to be offered; 23 were offered in the School in 1974-75. Moreover, the Center for Advanced Visual Studies, an Institute program closely linked to the Department of Architecture, offered a variety of educational activities for students, including participation in the design and implementation of several public, large-scale environmental art exhibits -- among them the "Food Show," held in the Building 7 Lobby in April, an interdisciplinary effort which drew on resources from many areas of M.I.T.

Overall, 313 subjects were taught in the School during the 1974-75 academic year, about half taught by each Department. Over the academic year, registration totaled 2,517 in architecture subjects, of which 36 percent were cross-registrations, and 1,724 in urban studies subjects, 42 percent of which were cross-registrations.

During 1974-75 a total of 45,837 credit units were taught in the School, representing 6 percent of all units taught at the Institute; 27,903 were taught in the Department of Architecture and 17,934 in D.U.S.P. The total credit units taught in the School have grown steadily over the last five years, after taking a major jump from 25,214 in 1968-69 to 39,574 in 1969-70.

Composition of the School

Faculty and Staff

Over the last five years, the number of faculty has remained relatively stable in the Department of Architecture, increasing from 31 to 39. The Department of Urban Studies and Planning faculty has grown considerably since, 1970-71, from 15 to 39. The number of women on the School faculty has doubled since 1970-71 to four this year. The number of minority faculty has increased from one to eight; in D.U.S.P. from one to six and in the Department of Architecture from zero to two.
Of the 32 other academic staff members in the School (lecturers, instructors, and senior lecturers), 24 are in the Department of Architecture and eight in D.U.S.P. Of the total, six are women, all in the Department of Architecture, and one is a minority group member who is in the Department of Urban Studies and Planning. The research staff of the School consists of one senior research scientist and seven research associates, one of whom is a woman.

The School's Affirmative Action Plan includes not only increases in the number of women and minority academic staff, but also similar increases in administrative staff and biweekly employees. The Department of Urban Studies and Planning has reached almost all its goals, while the Department of Architecture is making slower but substantial progress.

**Students**

Student enrollment this year was the highest in the history of the School: 559, including both regular and special (nondegree candidate) students. This represents a 14.5 percent increase over the 1973-74 enrollment, a 47.9 percent increase since 1969-70, and a 189.6 percent increase since 1964-65. Of the two departments, D.U.S.P. has experienced the sharpest growth in the last ten years, from 58 in 1964-65 to 232 in 1974-75, while in that period the Department of Architecture enrollment grew from 135 to 341.

For the School as a whole, 28 percent of the student body were women and 13 percent were members of minority groups. The table below gives data on enrollment and composition by degree program.

During 1974-75 the School's record with regard to women and minority group members was exceptional. With 6.9 percent of the total M.I.T. enrollment, the School had approximately 14 percent of all the women students and 16 percent of all the minority students at M.I.T. Furthermore, the School contains approximately 18 percent of all minority women and 23 percent of all graduate minority students at the Institute.

<table>
<thead>
<tr>
<th>Department of Architecture</th>
<th>Total</th>
<th>Women</th>
<th>% Women</th>
<th>Minority</th>
<th>% Minority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduates</td>
<td>148</td>
<td>20</td>
<td>13.5</td>
<td>10(2)</td>
<td>6.8</td>
</tr>
<tr>
<td>M. Arch.</td>
<td>99</td>
<td>34</td>
<td>34.3</td>
<td>16(3)</td>
<td>16.2</td>
</tr>
<tr>
<td>M. Arch. A.S.</td>
<td>47</td>
<td>9</td>
<td>19.2</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Special*</td>
<td>47</td>
<td>23</td>
<td>48.9</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Department Totals</td>
<td>341</td>
<td>86</td>
<td>25.2</td>
<td>26(5)</td>
<td>7.6</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Department of Urban Studies and Planning</th>
<th>Total</th>
<th>Women</th>
<th>% Women</th>
<th>Minority</th>
<th>% Minority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduates</td>
<td>76</td>
<td>21</td>
<td>27.6</td>
<td>7</td>
<td>9.2</td>
</tr>
<tr>
<td>M. C. P.</td>
<td>65</td>
<td>21</td>
<td>32.3</td>
<td>25(10)</td>
<td>38.5</td>
</tr>
<tr>
<td>Ph. D.</td>
<td>44</td>
<td>16</td>
<td>36.4</td>
<td>7(3)</td>
<td>15.9</td>
</tr>
<tr>
<td>Special*</td>
<td>47</td>
<td>15</td>
<td>31.9</td>
<td>10(4)</td>
<td>21.3</td>
</tr>
<tr>
<td>Department Totals</td>
<td>232</td>
<td>73</td>
<td>31.5</td>
<td>49(17)</td>
<td>21.1</td>
</tr>
</tbody>
</table>

(continued on next page)
**Student Enrollment & Composition, † 1974-75, School of Architecture and Planning**
(continued from preceding page)

<table>
<thead>
<tr>
<th>School Totals</th>
<th>Total</th>
<th>Women</th>
<th>% Women</th>
<th>Minority</th>
<th>% Minority</th>
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</thead>
<tbody>
<tr>
<td>Undergraduates</td>
<td>224</td>
<td>41</td>
<td>18.5</td>
<td>17(2)</td>
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<tr>
<td>Graduates**</td>
<td>250</td>
<td>79</td>
<td>31.6</td>
<td>48(16)</td>
<td>19.2</td>
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<tr>
<td>Special***</td>
<td>94</td>
<td>38</td>
<td>40.4</td>
<td>10(4)</td>
<td>10.6</td>
</tr>
<tr>
<td>TOTAL ENROLLMENT++</td>
<td>559</td>
<td>157</td>
<td>28.1</td>
<td>74(22)</td>
<td>13.2</td>
</tr>
</tbody>
</table>

†Enrollment figures are a count of students registered in the fall and spring terms; students registered in both terms were counted only once.

++Including five joint M.C.P.-M. Arch. A.S. candidates and nine joint S.B.-M.C.P. candidates (of whom two were women and one was a minority person).

*(Number of minority women).

**Nondegree candidates.

***Five students, including one woman, were joint M.C.P.-M. Arch. A.S. candidates.

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**Degree Programs and Admissions**

The professional degree programs in the School, the M. Arch. and the M.C.P., are being revised through the efforts of faculty and students. In the Department of Urban Studies and Planning, the joint S.B.-M.C.P. program has received formal approval as part of the Department's degree offerings. This program offers qualified undergraduates the opportunity to complete the requirements for both the S.B. in Urban Studies and the M.C.P. in five years.

After an extensive review by departmental and Institute committees, the M.I.T. Corporation last April granted the Department of Architecture the right to award the Ph.D. degree. The program, to begin in September, 1975, with four or five students, will initially focus on the history, theory, and criticism of architecture and art, and will evolve to include other areas in the Department. The Ph.D. program will permit linkage to other departments at M.I.T. by allowing students whose primary interests are in architecture to engage issues which can best be raised across departmental lines. The establishment of this program will help the Department maintain its traditionally innovative stance and further the School's position of professional and intellectual leadership in architectural education.

During the 1974-75 academic year, 159 degrees and 24 certificates were awarded to 169 students in the School, a substantial increase since 1970-71, when 112 degrees were awarded. In the Department of Architecture, 40 undergraduate degrees were awarded; 36 students received B.S.A.D. degrees and four received a B.S. as recommended by the Department of Architecture. In D.U.S.P., 21 undergraduates received the S.B. degree. Of the graduate degrees awarded, 27 students received the M. Arch., 24 received the M. Arch. A.S., 38 received the M.C.P., and nine received the Ph.D. in Urban Studies and Planning. Nine students received the joint S.B.-M.C.P. degree, and five were awarded both the M.C.P. and M. Arch. A.S. degrees. Altogether, 145 of the 465 students enrolled in the School's degree programs this year received degrees.

About one quarter of the special students in the School this year were enrolled in the two special nondegree programs offered by the Department of Urban Studies and Planning. In
June, 1975, the 14 Fellows in SPURS and the ten Fellows in C. F. P. were awarded certificates for completing one year of study at the Institute.

There were a total of 965 applicants for 99 "target" places this year in the School's four graduate degree programs. In the Department of Architecture for the M. Arch. degree program there were 383 applications for 36 target places, a ratio of 10 to 1; 39 were enrolled. For the M. Arch. A.S. program there were 86 applicants for 26 target places, a ratio of 3 to 1; 23 were enrolled. In the Department of Urban Studies and Planning there were 403 applicants for 25 target places in the M.C.P. program, a ratio of 16 to 1; 21 were enrolled. For the Ph.D. program there were 113 applicants for 12 target places, a ratio of 9 to 1; 9 were enrolled. Since 1970 the School of Architecture and Planning has experienced the sharpest increase in graduate applications of all the Schools at the Institute -- from 958 applicants in 1970 to 1,229 in 1974 (including special students), an increase of 28 percent.

Research

In conjunction with developments in the teaching programs, research activities, with funding in the School totaling close to $2 million for 1974-75, continue to grow and involve more faculty and students.

The Laboratory of Architecture and Planning, created in 1973 to foster research in the School, has seen an extremely productive year. The research volume of the Laboratory amounted to about $750,000 in fiscal year 1975. Following its second annual solicitation for proposals this winter, the Laboratory made awards totaling $60,000 to 21 projects submitted by faculty and students from the School. The awards came primarily from the Albert Farwell Bemis Fund which is administered by the Laboratory. The Laboratory staff stepped up their efforts to provide support services for other teaching and research activities in the School, and a manual setting forth the Laboratory's purposes, services, and research projects is being prepared. A limited number of large on-going research projects also continue in the Laboratory, including the Urban Ecology Study funded by the Ernest Grunsfeld Memorial Fund, and Innovative Resource Planning in Urban Public Safety Systems funded by the National Science Foundation.

Sponsored research volume in the Department of Architecture, amounting to more than a half million dollars, included studies of methods and materials for energy conservation in housing; a large scale research project on the design, evaluation, and uses of elderly housing, funded by the Department of Health, Education, and Welfare's Administration on Aging; further research on computer-aided design by the Architecture Machine Group, which this year was awarded a major grant from the National Science Foundation to continue its studies; and the Architecture Education Study, sponsored by eight eastern schools of architecture and funded by the Mellon Foundation. This study, administered by the Laboratory and housed in part by the M.I.T. Division for Study and Research in Education, has involved both faculty and students from the School in the first stages of its research.

The Department of Urban Studies and Planning, with about a half million dollars of sponsored research, has conducted multiregional analyses relating mainly to the transportation of goods, the analysis of urban public service systems, and a study of earned income of urban families and the urban labor market. Other projects administered by Department members and funded all or in part through the Laboratory include land use studies in Maine and Rhode Island; citizen-based planning efforts in Arlington, Massachusetts; and a study of public policy related to cultural planning and arts administration.
Research on critical issues of public policy, particularly in the field of housing, continues at the M.I.T.-Harvard Joint Center for Urban Studies. This summer Arthur P. Solomon, Associate Professor of Urban Studies in D.U.S.P., will become the next director of the Joint Center. Professor Solomon, Associate Director of the Joint Center since 1971, succeeds Bernard J. Frieden, Professor of City Planning in D.U.S.P., who has served as the director for the past four years. Professor Frieden, as part of his involvement with urban affairs, has also been a consultant to numerous Federal and state agencies, and has authored more than 30 articles and books on housing and urban planning. After a sabbatical leave next year, he will return to research and teaching at M.I.T.

Space Issues

The School Space Committee, comprised of members of the School and the M.I.T. Planning Office, met regularly throughout the year to deliberate allocations and renovations of space. For the 18,000 square feet in Building 10 which were acquired in 1973 from the Department of Electrical Engineering, designs have been prepared for partial renovation, and late this fall the presently scattered offices and studios of the Environmental Design Group will be brought together in one location in Building 10.

Two student-oriented space developments occurred during the year. Part of Room 335 in Building 7 was turned into the headquarters for the D.U.S.P. undergraduate program; the area now serves as a center for informal and formal undergraduate activities. Also, a group of more than 30 enthusiastic architecture students with a faculty advisor built the new Architecture Department Lounge. The project served as a learning experience in building for the students and fulfilled a longstanding need in the Department for a lounge area.

Despite these changes, three-quarters of the School's space -- six percent of the total space at M.I.T. -- has not yet been modernized, and more than half of the high quality area it presently occupies is available to the School only on a temporary basis. During the next few years, the School hopes this situation will be improved.

School Activities

The Rotch Library continues to serve well the teaching and research programs of the School. Computerized access to literature is now available for a small charge; videotapes and a television screen are being added. Despite its space problems, the Library managed to devote a small area to exhibition space so that students and staff members had the opportunity to exhibit their art work.

The School's Visiting Committee arrived on December 12 for two days (instead of the usual one) of reviewing the School's goals, activities, and plans for the future. The 11 attending members of the 15-member Committee met with the Dean, department heads, students, the School Development Council, and a number of Institute officials. They attended the Dean's sherry hour, made informal visits to various centers within the School, and also managed to spend half a day visiting each Department. Faculty and students in both Departments gave presentations and engaged the members of the Committee in discussions. After their visit, the Committee Chairman, I. M. Pei, gave his and the Committee's support and encouragement to the School's development.
This year the School began a major effort to establish communication links among members of the School and particularly between the School and its alumni. Three publications, the Report to the Alumni (August, 1974) and two Newsletters (December, 1974, and May, 1975) were distributed to all persons in the School and were mailed to our alumni, who now total more than 2,550. For each issue articles and information were solicited and received from faculty, staff, students, and alumni. The favorable reactions to these publications have confirmed the need for continued communications.

Alumni Day, June 6, provided another opportunity to forge stronger ties with alumni. During the morning program, Donald Schon, Ford Professor of Urban Studies and one of several panelists, spoke to M.I.T. alumni on current issues of governmental planning policy. The afternoon programs included a presentation by the Center for Advanced Visual Studies and four panel sessions run by and for Architecture alumni. In the evening, the Department of Architecture held an alumni dinner at which Dean Emeritus Lawrence Anderson was the keynote speaker.

Earlier this spring, the Department of Urban Studies and Planning held a successful fund-raising telethon in which several of the Department's alumni spent an evening calling alumni all over the country to ask for support. Activities of this nature will be continued in the future, as the School wishes both to serve and to engage the interests of its alumni.

The School's 1972-73 report to the President and the Chancellor mentioned the high national reputation which we held at that time. Indicative of the School's continued prestige, the December, 1974, issue of Change Magazine reported on a reputational study in which 29 out of 35 deans of university-affiliated schools of architecture place M.I.T. among the top five schools, giving it the highest ranking in the country. The Institute's encouragement and continued support of the School have been vital to its achieving and maintaining this leadership position.

WILLIAM L. PORTER

Department of Architecture

Major steps were taken this year toward five of the Department's long-term objectives. The Ph.D. program was authorized and students admitted for 1975-76; the first substantial space change program for the School was initiated, and construction has begun; faculty and students continued their review of the design curriculum and have initiated a summer study to reformulate the introductory design subjects; the arts program offerings have been enriched at the undergraduate level and plans prepared for advanced study; and the Department's Executive Committee and its Long Range Planning Committee have conducted studies of the Department's teaching program, budget, structure and administration, to set the stage for Professor Nicolaas John Habraken's term as Department Head beginning July, 1975.

These changes occur in the midst of continuing growth in the Department and steadily increasing demand for admission to the graduate program. We have a larger number of designated sophomore majors than ever before, which may bode further changes in the undergraduate program. In 1974-75, we enrolled 148 undergraduates and 146 regular graduate students. Of these 294 students, 26 were minorities and 63 were women.
New Doctoral Program

The new Ph.D. program in Architecture, Art, and Environmental Studies has admitted five students in 1975-76 and will grow to nine in the succeeding year. The program being initiated in the areas of History, Theory, and Criticism is the outgrowth of ten years of planning and will serve as the leading edge for the development of new standards for academic excellence in the profession. Its approval by the faculty, administration, and Corporation opens new opportunities for leadership in the field. This year was also the occasion for the first doctoral degree to be awarded by the Department. Marian Moffett (M. Arch. A.S., '73), earned her Ph.D. degree in a joint program with the Division for Study and Research in Education, with much of her work conducted under the supervision of Professor Julian Beinart in connection with the Mellon-funded Architectural Education Study. The Study is under the general direction of Dean William Porter and Dean Maurice Kilbridge of the Harvard Graduate School of Design. Candidates for the Ph.D. degree will participate in the teaching and research programs of the Department.

Space Change

Increasing graduate and undergraduate enrollment and research activity have led to unprecedented demands for space. The initiation of a major renovation program in the main building has come just in time to relieve the most grievous burdens. The first steps of a long-range space renovation program include modest renovation of some of the space vacated by the Department of Electrical Engineering in Building 10 to make it usable for the Environmental Design Program, and major renovation and consolidation of the Department Headquarters and adjoining offices in Building 7 to make room for the Rotch Library Visual Documents Collection, a combination slide room and photographic study area that will serve as a primary graphic study resource for the Department and relieve the serious overcrowding in Rotch Library. These are extremely welcome first steps in the long-term plans to accommodate the School's activities in the main complex.

Also, during Independent Activities Period (I.A.P.), a group of students designed and built a new student lounge opposite the Building 7 elevator on the fourth floor to draw out the potential for informal communication that is implicit in such a major circulation node.

Design Curriculum

Following on the year long study conducted in 1973-74 by Professor Chester L. Sprague's committee on the Design Curriculum, and fueled by student concern and enthusiasm, the faculty took serious stock this spring of its offerings in architecture design and initiated efforts to make subject content of the various studios more explicit, better coordinated with other offerings, and more widely understood. This is not an easy task, since the strengths of the Department's program lie in its willingness to integrate design teaching with studies in technical innovation, exploration of community needs, and engagement with a variety of situations outside the Institute.

Design projects this spring, for instance, were extremely varied. Professors Timothy E. Johnson of M.I.T. and David Lord of Harvard conducted a joint M.I.T. -Harvard studio concentrating on methods of energy conservation, utilizing research conducted in the Department.
Myron Guran's studio worked on an exploratory design for exhibition and advanced study facilities for the arts on Memorial Drive adjoining Walker Memorial. Professor Robert J. Slattery's students worked on the renovation and design for Park Street Subway Station in conjunction with the architects for the project and the Boston Redevelopment Authority. Professor Tunney Lee and Professor Philip Herr of the Department of Urban Studies and Planning conducted reuse studies for Dudley Street Station and adjoining areas working with the Southwest Corridor Coalition. Professor Richard Tremaglio's group did studies for Cambridge High School. Professor John R. Myer led students through the preparation, for a real client, of final design and construction documents for a house on Cape Cod. Professor Jan Wampler instructed his students through the design of a complex of housing in Northboro, Massachusetts. Professors Imre Halasz and Wayne V. Andersen studied mixed use development in Back Bay. Visiting Professor Ezra Ehrenkrantz and Professor Waclaw P. Zalewski conducted building system studies for General Services Administration projects.

In addition to these many study projects, Professor Gary A. Hack and a group of students, with aid from the Albert Farwell Bemis Fund, prepared a series of video recorded case studies of large scale environmental design projects for use in classroom discussion of processes and issues encountered in contemporary professional activity. New special subjects in lighting, site engineering, and the history of vernacular town planning were also offered this year in response to design-related interests of the students and faculty.

An internship program for students in the design curriculum was started with the aid of alumni who are principals in several local architectural firms, including the PARD Team, Childs Bertman Tseckares Associates, and Stahl/Bennett Inc. The Architectural Assistance Program, ably conducted by Ann Beha and Michael Harris, also served as a channel for a variety of student job opportunities in the field that supplemented income and often provided hands-on experience with building.

As these various efforts continue during the next year, the Department will benefit from Professor Beinart's study of the settings for design teaching in other schools. The research has been conducted by the Architectural Education Study and is continuing into the fall term, 1975. The Department's openness to innovation in design teaching must now be matched by an articulation of objectives that can help students give order to their experiences and plan their sequence of subjects.

Presently, a curriculum development summer study, chaired by Professor Myer, is devising a new one-term team-taught introductory design offering that can serve as a common foundation for subsequent subjects and a forum for faculty discussion of design objectives. This subject would follow the new introductory subject, required of all students in the Department, which was initiated this year by Professor Donlyn Lyndon and Karen V. Wheeler, Instructor in the Department. This subject, Representations of Place, introduces students to the full range of offerings in the Department and includes lectures and projects conducted by Department faculty in design, building technology, history, theory and criticism, and the arts, as well as by faculty from the Departments of Urban Studies and Planning and Humanities.

The Arts

The Department's arts program in Film, Photography, and the Visual and Environmental Arts has continued to burgeon and become more vital without significant new funding. The Center for Advanced Visual Studies (C.A.V.S.) has become extremely active in the educational program with special studies and projects conducted under the Center's Director of Educational Programs. The Center's energetic involvement in the life of the M.I.T. community has also
brought into the open vivid evidence of the fertility as well as the controversy that is implicit in a creative arts program that challenges conventional sensibilities. The level of interest in the arts that has developed in the last years now strains our budgeted capacities.

The Visible Language Workshop, especially through the efforts of Professor Jonathan W. Green, Muriel Cooper, and Ronald L. MacNeil of this Department, and Professor Patricia Cumming of the Department of Humanities, has become an extremely busy and lively center of arts instruction and service to the M.I.T. community. Its continued growth beyond the present tenuous level of funding will be a support to all elements of the Department and can continue to serve as a project meeting ground for faculty and students from many programs.

Opportunities for the use of video that have been made possible through the Sloan grant to the Center for Advanced Engineering Study have spurred several new developments. Ann McIntosh, Lecturer in the Film program, has led that group in the development of video work. Melissa Shook, Lecturer in Photography, experimented with video in the writing and photography subject that she taught in the spring term with Professor Sanford Kaye of the Department of Humanities. Professor Richard Leacock and Ms. McIntosh conducted an I.A.P. television workshop that produced a startling rendition of Aristophanes' The Birds combining camera work, dance movement, video recording, and video effects in a live performance.

The Faculty Arts Advisory Group, chaired by Professor Lyndon and including members of the faculty from the arts, the humanities, science, and engineering, continued to consider development plans and facilities needs for an expanded role for the arts in M.I.T. education, with special attention to the opportunities and benefits of an advanced study program in the arts.

Department Activities

Professors Andersen, Myer, Leacock, Edward B. Allen, Department Head Lyndon, and Leon B. Groisser, Executive Officer, constituted an Executive Committee for the Department this year which was primarily responsible for budget policy and personnel decisions. Their deliberations set direction for the coming year, especially their decisions to reduce the technical support staff, to run a summer session, to consolidate subjects and admit ten additional graduate students next term, and to conduct, with Professor Habraken, a national search for two designers and a research coordinator. These were conducted in accordance with the new Affirmative Action Plan prepared by Professors Groisser, Whitney, Chadwick, and Dolores Hayden.

The Department was host this year to two symposia: "Current Perspectives in Revolution and Architecture in the Late 18th Century," chaired by Professor Stanford Anderson, and "American and Russian Urbanism in the 20th Century," with Manfredo Tafuri, Professor at the University of Milan, as principal speaker in a series of seminars, followed by a faculty seminar on "Politics, Architecture and Planning in American History," organized by Professor Hayden.

Professor Habraken visited the Department three times during the year to meet faculty, and to join in the deliberation of the Executive Committee and the faculty review of the design curriculum. The Long Range Planning Committee, chaired by Professor Stanford Anderson, prepared a position paper on Department governance, at Professor Habraken's request, that can guide him in establishing patterns of conduct for the Department next year.

On Alumni Day the Department hosted a Convocation of Alumni from the Department of Architecture, with panel discussions on "The Evolution of Practice, 1975-85," "Architects in Public
Service, "and "M.I.T. Women in Architecture," chaired by I. M. Pei, '40, Chairman of the School Visiting Committee, John Merrill, Jr., '49, Harold Horowitz, '51, and Marjorie Pierce, '22. In the evening Lawrence B. Anderson, '30, Senior Lecturer, Professor, and Dean Emeritus, addressed the alumni who attended the special Department of Architecture alumni dinner.

Faculty, Staff, and Students

During the course of the academic year a number of new staff members joined or visited the Department. Alan Balfour was appointed lecturer to conduct an energy workshop studio and has since become Associate Director of the Architectural Education Study. Peter Hopkinson and Mark Waltch were appointed as lecturers in the fall term to conduct an urban design studio. Robert Manoff was appointed as part-time lecturer and has since been admitted to the Ph.D. program. Ms. McIntosh served as lecturer in the Film group and continued work on the development of video. David Moizer was appointed Visiting Professor of Building Technology on leave from Carleton University. Tod Papageorge was appointed lecturer in Photography and has been appointed at Harvard's Carpenter Center for 1975-76. Ms. Wheeler was appointed instructor to teach Representations of Place. Michael Underhill was appointed lecturer to teach introductory design. David Lee has been appointed Assistant Professor in the Environmental Design Program. Sandra Howell, Robert Slattery, and Sean Wellesley-Miller, all previously members of the academic staff, have been appointed to professorial ranks. Werner Oechslin served during the spring term as Visiting Lecturer in Architectural History from the University of Zurich; Abraham Ben-Arroyo was Visiting Lecturer in the spring from the Technion in Israel.

International visitors included Dr. Vera Hole, a social anthropologist from England, who shared her work in environment behavior research; Professor Manuel Castells of the Sorbonne, who visited the School for a week of classes, lectures, and discussions in urban sociology; and Peter Cook, an architect from London. These visits as well as those of Mr. Oechslin and Professor Tafuri were made under the auspices of the School's Ford International Visiting Professorship Program.

Professors Maurice K. Smith and Minor White were on sabbatical leave. Senior Lecturer Albert G. H. Dietz and Professors Judith Wechsler, Dolores Hayden, and John Terry had professional leaves during the year.

Professor Anderson spent one term as Visiting Critic at the Universidad Catolica de Chile in Santiago, Chile; Albert Dietz was both Senior Lecturer at the East/West Center in Honolulu, Hawaii and Visiting Professor in the Civil Engineering Department at the University of Hawaii.

Gyorgy Kepes, Institute Professor Emeritus, received the first $1,000 McDermott Award from the Council for the Arts. He spent the year on leave as Artist in Residence at the American Academy in Rome, where Professor Henry Millon still serves as Director.

Ms. Cooper, Lecturer in the Department's Visible Language Workshop, received a silver medal in the Fourth Biennial International Art Books Contest held in Israel this past spring.

Professor Lyndon was a member of the International Selection Committee for the 1975 International Union of Architects Student Competition held in Madrid, Spain. He also has served this past year as Chairman of the Association of Collegiate Schools of Architecture (ACSA) Publications Committee and was recently elected Vice President of the ACSA.
Professor Hack was a recipient of Progressive Architecture's First Award in their annual Design Awards Program for his study on the night environment and ways of improving it.

Professor Wampler and Lecturer Lawrence Speck each led student teams that received recognition in architectural competitions sponsored by the Massachusetts Department of Community Affairs. Professor Wampler's entry in the Dracut competition was one of four finalists selected for interview. Mr. Speck's entry to the Fitchburg competition received fourth place. An entry by Mr. Guran and Susan Myers to the New York Urban Development Corporation Roosevelt Island competition was selected for exhibit.

This year there was renewed interest among students in the consideration of curricular and departmental structure, and many participated generously in the Departmental review. Students also took responsibility for a great variety of organizing and building projects throughout the Department, utilizing more than $30,000 in Work-Study funds.

As in the past, the Lectures program has been run by students, this year chaired by Ms. Myers, with four distinct series: Women in Architecture, Alternate Modes of Practice, Black Architects, and American Architecture. This spring Baked Form, the congenial Wednesday noon Department lunch hour, was revived under the direction of Peter Karb and Jill Kurfirst.

A number of student prizes were awarded. The Alpha Rho Chi medal for service to the Department was presented to Ms. Beha and Mr. Harris, originators of Baked Form and the Architectural Assistance Program. American Institute of Architects medals were given to Stephannie Bartos and Ann Abernathy, the Chandler Prize to Henry Plummer, and the Chamberlain Prize to James Czajka. The Anonymous Traveling Fellowship was divided between Juniper Russell and Andrew Miao, and a special letter of commendation was sent to Charles Styron for his distinguished assistance in the Department.

Andres Schcolnik received an Eloranta Fellowship grant and a grant from the Bemis Fund to study and investigate the design and building of Japanese gardens while serving as an apprentice to a master gardener in Japan.

During 1974-75, as in the past several years, a number of students were able to extend their thesis study projects through support from the Graham Scholar's Fund.

Research

Research activity continued apace in the Department this year with contracts from the National Science Foundation and the Office of Naval Research for Professor Nicholas P. Negroponte's continuing work with computers. The Architecture Machine Group's laboratory capabilities also have been expanded through the acquisition from Computervision of a computer-aided design system which includes a large plotter/digitiser that will enable greater use of the system by architects.

Professor Sandra Howell's Design Evaluation Project, now in its second year of funding by the Department of Health, Education, and Welfare, has proceeded through the examination of a national sample of projects to house the elderly and is developing design guidelines and publishing evaluation reports.

The Urban Ecology research program directed by Professor Stanford Anderson received an additional three year study grant from the Ernest Grunsfeld Memorial Fund, with Hong Bin Kang entering the Ph.D. program next year as the first Grunsfeld Research Fellow.
Gunter Nitschke's study of the Japanese Ritual of Renewal at the Ise shrines has been under way throughout the year in Japan, funded by the National Endowment for the Humanities.

The program in Urban Settlement Design for Developing Countries, directed by Professor Horacio Caminos, received a grant from the World Bank in partial support of their continuing research on standards for the layout and design of low cost housing settlements to meet the urgent needs created by urban migration in developing countries.

Professors Johnson and Wellesley-Miller have conducted a research program with National Science Foundation support directed to the development of new insulating materials and collection techniques for the use of solar energy in buildings.

Publications

Books and articles authored by Department faculty included: The Place of Houses by Professor Lyndon, Charles Moore, and Gerald Allen (Holt, Rinehart, and Winston, 1974); Professor Negroponte's Soft Architecture Machine (M.I.T. Press, 1974); "The Urban Land: A Progressive Development Proposal" by Professor Caminos in Ekistics, (Vol. 38, No. 227, October, 1974); Professor Dietz's "Building Materials" in Progressive Architecture (September, 1974); "Shime: Binding/Unbinding" by Lecturer Nitschke in Architectural Design (December, 1974); Professor Piene's Inflatable Flowers Red Rapid Growth (picture) in "The Avant Garde Festival: and Now Shea Stadium" by Peter Frank, Art in America, (November/December, 1974); Professor Wampler's "Imprint. People and the Places They Build" in Architecture Plus (July/August, 1974); Professor Wechsler's "Review of As They Were: Celebrated Peoples' Pictures by Tuli Kupferberg and Sylvia Topp" in Aperture (Vol. 19, No. 1, 1974).

Publications edited by Department faculty included: Professor Wechsler's Cezanne in Perspective (Prentice-Hall, Inc., 1975); Professor Allen's The Responsive House (M.I.T. Press, 1974); and Professor Green's The Snapshot, published as a single issue of Aperture (Vol. 19, No. 1, 1974).

DONLYN LYNDON

Department of Urban Studies and Planning

Academic year 1974-75 was one of transition for the Department of Urban Studies and Planning (D.U.S.P.). Four years under the creative and energetic leadership of Professor Lloyd Rodwin had fundamentally transformed the size, scope, and resources of the Department. When Professor Rodwin stepped aside from the leadership position, he left behind "an impressive faculty and staff, a capable body of students, a solid reputation, and promising prospects" (1973-74 Report to the President). Professor Rodwin's performance would be difficult to follow under any circumstances, but in an era in which both internal and external sources of funding were rapidly shrinking, there were scant possibilities of continuing the expansion of people and resources at the rate established during the past four years. While the scarce resource climate provided the most obvious constraint on growth, there was, in addition, a general sense within the Department this year that it was time to take stock of where we were, to look carefully at the assemblage of people and subjects, and to examine the extent to which they constituted or might constitute a coherent approach to the teaching and learning of urban studies.
and planning. As soft money dried up, as foundations became less financially accessible, and as the Institute itself pushed harder on issues of educational efficiency and cost-effectiveness, the need to justify each and every component of the Department became not only a matter of intellectual integrity but organizational survival as well. Financial necessity and the drive toward coherence resulted in several major policy decisions: an effort to cut down on the number of part-time people teaching in the Department, increased focus on sponsored research as a means of faculty and student support, and a reorganizing of the subject offerings into a more integrated set of enterprises.

While termination of five part-time faculty at the end of 1974-75 represents a loss of diversity, it also signifies implementation of the consensus that coherence begins in the first instance with the presence of a core of faculty whose full-time commitment is here in the Department. The financial role of research was clear from the start, i.e., one way of dealing with a shrinking financial base is to ask faculty to cover more of their salary with sponsored research; but the substantive issue around research is the extent to which it furthers and enhances the academic program within the Department. Not only was a significant amount of research already going on within the Department, both funded and unfunded, but research served as a significant means of linking faculty and students in enterprises of joint concern. In an Institute where research is at the center of the academic experience, our revelations about the role of research may appear to be self-evident. It is important to remember however, that the Department is in a very real sense a mixture of several cultures, not all of which have viewed financial support through research as a fundamental component of academic life.

The reorganization of the curriculum was more than an effort to clean house. It occurred in large part as a result of efforts to rethink the way in which the diverse intellectual interests of the Department could best be organized. The most significant element of re-sorting was the combining of what had previously been two independent program groups, the Analysis of Public Systems and Social Policy groups. Our study last summer of the Master in City Planning degree made clear that the two groups were focusing on many of the same issues and that a union of effort would enhance both. This merger (discussed further under Public Policy Analysis) is but one example, if perhaps the most significant, of the efforts throughout the year to make the curriculum more coherent.

In addition to this effort at self examination, the year has been marked by a major effort to restructure the governance processes in the Department. The diversity of our enterprise, with its variety of interests and perspectives, makes it impossible, even if it were desirable, to run events totally from a central point. In recognition of this, operating responsibility for the three degree programs, Undergraduate, M.C.P., Ph.D., has been assigned to committees of faculty and students. The three program groups, Environmental Design, Public Policy Analysis, and Community and Regional Development, have their own committee structure and leadership. The Department Policy Committee, made up of representatives from these six groups, constitutes the governing body of the Department. The group, which meets weekly, has had the prime responsibility for major issues confronting the Department as a whole. It is clear that decentralization has provided a means of increasing the number of people who have a "stake" in how the Department operates. This has been all to the good. What remains to be demonstrated, however, is the most effective way in which the senior, i.e., the tenured, faculty can best relate to an organizational system which does not focus on them as the central mechanism for Departmental decisions. The governance change, like that of staff consolidation and research and curriculum review, constitutes a major theme cutting through the specific activities described below.
Degree and Non-Degree Programs

Undergraduate Program

The Undergraduate Program was directed by Professor Gary Marx during 1974-75. Professors Suzann and Leonard Buckle were Co-Associate Directors of the Program and coordinated undergraduate fieldwork and research activities. The more than 20 undergraduate subjects were organized into five broad areas: environmental design; public systems and urban management; urban planning and development; law, urban institutions and social change; and human resources planning. New subjects offered included 11.81 Social Research Methods, taught by Professor Phillip Clay, and introductory two-term sequences in the areas of both urban planning and development, and law, urban institutions, and social change. An additional change in the undergraduate curriculum was the broadening of the thesis to include not only traditional research but also policy analysis and problem-solving experiences.

Undergraduates especially interested in transportation or environmental planning now have the opportunity to take subjects in both the Department of Urban Studies and Planning and the Department of Civil Engineering under a new joint program approved in spring, 1975. Undergraduate majors in either department may take a specialized set of subjects spanning the requirements of both departments within the normal Bachelor's degree program of 360 units. A committee composed of faculty from the two departments will advise these students.

Twenty-one students received the Bachelor of Science in Urban Studies in June, 1975; nine of these students also received the Master in City Planning degree. An additional 11 seniors were accepted into the five-year S.B./M.C.P. program and will receive their Bachelor's degrees in June, 1976. Additional undergraduate enrollment included 54 juniors and sophomores. A number of undesignated undergraduates were also advised by D.U.S.P. faculty.

Master in City Planning (M.C.P.) Program

1974-75 was a year of intense preparation for major changes in the M.C.P. program. A group of D.U.S.P. faculty and students spent five weeks during the summer of 1974 evaluating the M.C.P. program. They recommended the following changes in the focus and content of the two-year professional degree program:

1) An increased focus on professional practice; specifically the redesign of 11.01 The Planning Process, an introductory subject required of all entering Masters students. This subject will introduce students to basic concepts and theories of planning practice and encourage them to explore their own modes of action in a variety of professional contexts. The development of subjects with practice-related skills and increased concern for the needs of practitioners were also recommended.

2) The design and implementation of subjects in three areas identified as critical to effective planning: Urban Economics, Analytic Methods, and Institutional Analysis. Faculty and students have worked together during 1974-75, debating the content of these subjects and designing them to be offered in 1975-76 in a mode appropriate to the needs of planning students. Beginning in fall, 1975, all entering M.C.P. students will be required to take or test out of these three "core" subjects. Also at the recommendation of the summer study, subjects
have been developed in Urban Law and Sociology for students in the professional degree program. While these subjects will not be required, it is envisioned that they will be central to the program of students in a variety of specializations.

3) The definition of clear sequences of subjects suited to the needs of M.C.P. students in the three program areas of the Department: Environmental Design, Community and Regional Development, and Public Policy Analysis. In response to this recommendation, the three program groups spent considerable time during 1974-75 reexamining the curriculum and subject offerings from the perspective of the needs and interests of M.C.P. students in their groups. New subjects have been designed and existing subjects redesigned, making it easier for students to identify an appropriate sequence of subjects within their area of specialization. The seven areas of specialization presently identified at the Master's level are: Housing, Health Care, Criminal Justice Planning, Urban Design, Environmental Management, Community Development, and Regional Development.

Redefining the M.C.P. thesis to make it more directly related to professional practice has been recommended. During 1975-76, students will be encouraged to utilize a variety of forms of thesis, allowing them to synthesize theoretical issues and field experience in a manner appropriate to their individual sense of professional competence and career direction. The way in which learning can be enhanced by field experience will also receive careful consideration during 1975-76. This process will draw heavily on the experience of the Housing and Urban Development Minority Intern Program, now in its fourth year, which annually places 20 first and second year minority M.C.P. students in part-time positions in public and nonprofit agencies in the Boston area. Phillip Clay, Director of the Intern Program, has developed diagnostic and monitoring tools for intern field activities which will be extended to all M.C.P. students during 1975-76.

The M.C.P. Committee, under the leadership of Professor Thomas Nutt, took an increasingly active role this year in advising students and monitoring their progress through the program.

Sixty-five students were enrolled in the M.C.P. program during 1974-75, including nine from foreign countries and 25 minority students, of whom 17 were black Americans, three Asian-Americans, two Chicanos, one Puerto Rican, and two American Indians. The Department awarded a total of 38 M.C.P. degrees in September, 1974 and February and June, 1975. Nine of these degree recipients also received the B.S. in Urban Studies. The Department received 339 applications to the M.C.P. program, 222 from men and 117 from women, of which 73 were from foreign and 48 from minority students. Of the 37 that were offered admission, 18 were minorities, 17 were women, and 20 were men; 4 were from foreign countries.

Ph.D. Program

Under the chairmanship of Professor Donald Schon, the Ph.D. Committee addressed a number of major concerns in administering the Ph.D. program during 1974-75, including:

1) Restructuring the program's administrative apparatus to encourage closer contact with individual students and to provide more rigorous monitoring of students' progress through the program.

2) Redesigning the first year seminar (required of all entering doctoral students) to better meet the objectives of the program -- to teach students basic skills in research design and implementation. Although judged more successful than in
previous years, it was felt that further consideration had to be given to the seminar's design. In particular it seems important to refrain from using the seminar as a screening device for first year students, and it was agreed that this element should be eliminated from the seminar in future years.

3) Developing admissions criteria and reorganizing the admissions process. The principal issues addressed were: how might the process be redesigned to emphasize academic excellence and potential for contribution to the role of the Ph.D. Committee; what should be the role of the Program Groups; what should be the process of affirmative action? Extensive discussions of these issues resulted in a redesigned admissions process administered by the Ph.D. Committee.

4) Overall review of the doctoral program. In the course of the year, many discussions were held about the fundamental design of the program. It was decided that a summer study of the doctoral program should be held during May and June, 1975, to address both the fundamental design questions -- objectives of the program, quality of the curriculum, quality of the advisory process -- and specific program questions -- first year seminar, core requirements, general examinations. The report of the study will be available by September, 1975.

There were 44 students enrolled in the Ph.D. program during 1974-75. Of these, 15 were from foreign countries; the seven minority students included four black Americans, two Puerto Ricans, and one Asian-American. An additional 14 students are on leave from the program but wish to continue working to complete their degrees. The Department awarded eight doctorates during 1974-75. There were 108 applications to the Ph.D. program, 89 from men and 19 from women, 38 of which were from foreign and 15 from minority applicants. Of the 25 that were offered admission, 17 were men and eight were women, five of whom were minorities and three of whom were foreign students.

Community Fellows Program

The Community Fellows Program, under the joint leadership of Professor Frank Jones and Lecturer Mel King, has completed its fourth year under a Rockefeller Foundation Grant. Extensive discussions in the Department, School, and Institute produced a consensus that the program is valuable and should be continued. The decision was made to spend 1975-76 as a planning year, developing specific mechanisms by which to genuinely integrate the Fellows program into the workings of the Department and to insure the best possible match between M.I.T. resources and the goals of the Fellows. We feel that the original objectives of the Community Fellows Program are still valid; that there are midcareer men and women from minority communities in positions of responsibility in public and private agencies and organizations who could benefit from a year of involvement at M.I.T. Given the consolidating focus of the Department around professional practice, a clear objective of the program would be to match the midcareer professional's needs, concerns, and experience of the Fellows with faculty interests and subject offerings in the Department. The practical experience of the Fellows should be viewed as a particular resource to younger students, especially those in the professional degree program.

Professor Hubie Jones, the new director of the program, and Lecturer King will spend 1975-76 planning for the future of the program and exploring sources of financial support. The next group of Fellows will be chosen for 1976-77.
Special Program in Urban and Regional Studies (SPURS)

The ninth year for SPURS has to be judged a successful one in terms of the quality of the Fellows and their accomplishments during the year. As usual, the group of 15 Fellows was diverse, coming from Brazil, Columbia, Ghana, India, Iran, Jamaica, Japan, Korea, Pakistan, and Uganda. Backgrounds were also diverse, ranging across architecture, law, political science, commerce, economics, and operations research. The Fellow's average wage and amount of experience in operational roles was somewhat higher than in recent years, thus fulfilling a recruiting goal. Support from the Ford Foundation ended this year; however, we have succeeded in recruiting qualified candidates funded by international agencies and other organizations (this year support of Fellows was obtained from the Ford Foundation, United Nations, USAID, The Organization of American States, UNICEF, and government and private agencies in specific countries sending candidates). Thus it is clear that mechanisms other than foundation grants exist for providing financial support for Fellows. In addition, the Department has absorbed faculty costs of the program into its budget, a painful but necessary experience during a period of declining general funds.

While the Department has committed itself to the continuation of the SPURS program, specific issues of the relationship between SPURS and the regular degree programs remain to be worked out. The Fellows compete with other students for faculty time which will become more scarce if departmental resources are cut back. On the other hand, the Department is strengthened by the presence of the Fellows who bring a high level of maturity and experience to the classroom. Furthermore, given the restricted number of regular students whose primary interest relates to developing countries, the SPURS program provides a critical mass of students to permit degree programs to offer specialization in this area.

Professor John Harris has been the acting director of SPURS during 1974-75 and has administered the program with the able assistance of Professor Karen Polenske and Instructor Zmarak Shalizi. Professor Rodwin will return from sabbatical to resume leadership of the program in 1975-76 and, having relinquished his post as Department Head, will be able to devote considerable time and leadership to SPURS.

Program Groups

The three program groups had been a primary focus of Department activity during 1974-75. Students and faculty have worked together evaluating the curriculum from the perspective of their groups, designing new courses, redesigning old courses, and setting priorities for future development.

Community and Regional Development

Curriculum development, particularly at the Master's level, was the focus of the program group's activities this year. Under the able leadership of Professors Polenske and Bennett Harrison, a steering committee of faculty and students worked to set priorities for this group and to define more explicitly the needs of students in both the degree and nondegree (SPURS and Community Fellows) programs. The absence of Professor Rodwin and spring term leave of Professor Ralph Gakenheimer (teaching at Berkeley) were offset by the return from leave of Professors Harris and Lisa Peattie.

Concrete results of the group's activities included: 1) an undergraduate seminar in urban and regional development taught by Instructor Adriana Stadecker, and 2) a speakers
series covering such topics as "The Indio-Hispanic (Mestizo) from the World Perspective," "Third World Women's Issues," "Welfare Reform," "Applications of the West Virginia Input-Output Model to State Energy and Pollution Problems," and "Community Development Corporations." New subjects planned for next year include an undergraduate seminar in Community Development taught by Professor Frank Jones and a seminar for Masters students interested in development issues taught by Mr. King.

Public Policy Analysis

The Public Policy Analysis Group represents the merger of two program groups: Social Policy and Analysis of Public Systems. During the year, extensive discussions have taken place around the design of a curriculum for the newly formed and more newly named cluster. Under the leadership of Professors Richard Larson and Martin Rein, the group has proposed a curriculum based on the application of discipline-based knowledge to substantive programmatic areas (housing, health care, criminal justice) and social problems (e.g. poverty, inequality). A series of "cross-cutting" policy analysis courses have been devised to capture the interrelationship among disciplines and the issues common to social programs. These policy analysis subjects will be the center of the program group's curriculum and will provide a setting for integrating research or experience with formal analysis and discussion of problem definition, program design, evaluation, and evaluative research. The group has also discussed the importance of field placement and has recommended that the Department place more emphasis on assisting students in identifying appropriate field experience.

In the context of this curriculum redesign, Professors Joseph Ferreira and Thomas Willemain will join Professor Schon in teaching 11.521 Social Service Systems in 1975-76. Each professor will bring to the subject experience in a particular substantive area, increasing the possibilities of "cross-cutting" analysis. This subject will be viewed as central to the program group and will be recommended to all graduate students specializing in public policy analysis.

Professor Alan Altshuler (appointed jointly with the Department of Political Science) will teach a graduate seminar in Urban Politics and Public Policy, and Professor Ken Colton (on leave as a White House Fellow during 1974-75) will return to teach subjects in planning and urban management. Professors Rein and Frieden, long-standing Social Policy group members, will be on leave in 1975-76.

The Social Policy Studio, offered for the first time in 1973-74, was offered again this year, primarily for M.C.P. candidates. Under the direction of Professors Peattie and Langley Keyes, the students analyzed the problems of vacant high-rise buildings in two state public housing projects in Cambridge and made recommendations to the Cambridge Housing Authority for the future use of these buildings. These recommendations have been adopted by the Authority.

Environmental Design

The Environmental Design program group brings together faculty and students from both the Department of Urban Studies and Planning and the Department of Architecture. Several new part-time faculty joined the Environmental Design faculty to teach during 1974-75, including Robert Manoff, formerly a borough director of planning in New York City; Peter Hopkinson, an architect with Skidmore Owings, and Merrill; David Lee, design director for Stull Associates; and Terry Schnadelbach, a landscape architect from Philadelphia. Efforts by the Environmental Design Search Committee resulted
Department of Urban Studies and Planning

in the hiring of Professor Alcira Kreimer, of the University of California at Berkeley, who will teach 11.132J Shaping the Urban Environment during 1975-76. Professor Hack, who developed this subject and taught it during 1974-75, will take a leave of absence for the academic year 1975-76 to direct an experimental program for housing prototypes for the Canadian government's Central Mortgage and Housing Corporation in Ottawa. Professor Hack helped to establish the School's Environmental Design Program and served as its Director for the past two years. Tunney Lee, Associate Professor of Architecture and Urban Planning in both departments, will serve as Director next year.

New courses taught during 1974-75 included 11.943 Urban Ecology taught by Professor Schnadelbach, 11.948 Site Engineering taught by Professor Kevin Lynch, and 11.302 Shaping the Urban Environment, which was developed during the summer of 1974 with Bemis funds and taught by Professor Hack. The Environmental Design Total Studio, offered for the second year, studied the future of the Dudley Station area of Roxbury. Under the direction of Professors Lee and Philip Herr and Harvard Loeb Fellow Tony Pangaro, graduate students in architecture and planning produced alternative physical and development packages and presented their findings and recommendations to the Southwest Corridor Coalition.

Curriculum development efforts of the Environmental Design group have resulted in several new offerings for 1975-76. Starting in September, 1975, a new specialization in Environmental Management will be possible through the redesign of existing courses and the institution of some new ones. Faculty principally involved in this specialization are Professors Philip Herr, Michael O'Hare, and Lawrence Susskind. The discussions around the new specialization led to reordering the environmental design curriculum into introductory, intermediate, and integrative subjects. The two introductory subjects will be 11.360 Community Growth and Land Use Planning taught by Professor Herr and a new course on Urban Structure taught by Professor Lynch.

The lectures sponsored by the Environmental Design Forum during the year, the traditional "Saturday Think" held in the fall term for faculty and students in Environmental Design, and the spring picnic held on Long Island in the Boston Harbor all contributed to the cohesiveness and effectiveness of this program group.

Research and Fieldwork Activities

The role of research activities in the Department has been discussed at length during 1974-75 by the Department's Policy Committee. The importance of research from both a learning and a budgetary perspective was carefully considered and policies proposed to encourage faculty to link their research and professional activities more closely to the activities of the Department.

Major research projects of D.U.S.P. faculty include the Multi-Regional Input-Output (MROI) research project directed by Professor Karen Polenske with funding from the Department of Transportation; Innovative Resource Planning in Urban Public Safety Systems (IRP), a project funded by the National Science Foundation and directed by Professor Richard Larson; and a project entitled "Earned Family Incomes" sponsored by the Center for the Study of Metropolitan Problems, of the National Institute of Mental Health, and conducted by Professor Bennett Harrison in cooperation with a research team from the Research Center for Economic Planning in New York City.
Major field-linked projects underway during 1974-75 included the following:

1) The Maine Land Use and Development Project undertaken during the summer of 1974, supported by funds from the Rockefeller Foundation, the Bemis Fund, and the State of Maine. Members of the team headed by Professor Rodwin included Professors Hack, Herr, Philip David, William David, and Lynch, as well as students from the Department.

2) Professor Susskind and a group of D.U.S.P. students have worked closely with the Town of Rockport during the past two years helping to create Citizens for Rockport, a resident group concerned with long-range problems of increasing tourism, shortage of low and moderate income housing, and environmental resource management. With the support of Bemis funds, 14 students spent the summer of 1974 working in Rockport helping citizens to develop policy recommendations on these issues. A paper written by eight of these students reviewing and analyzing their experience has recently won the Aschman Prize, awarded by the American Society of Planning Officials for articles written by planning students.

3) A project similar to the Rockport experience is being undertaken by Professor Susskind with a group of Department students in the Town of Arlington.

4) Professor Thomas Nutt, with a group of Department students, has been working in Rhode Island during the past year assisting the Governor's Policy and Program Review staff in generating a policy process for state development strategy. The group's main objectives have been to review the state's policy options, development potential, and implementation opportunities, and to establish a context for subsequent technical studies.

Many smaller scale research and field-linked projects took place during 1974-75. A survey conducted by the Policy Committee in April, 1975, indicated that almost all students in the Department participated at some point in faculty-supervised research and fieldwork and considered this activity among their most valuable at the Institute. As in previous years, members of the faculty served during the year as advisors to local, state, and national agencies and organizations, both in this country and abroad.

Promotions and Honors

Instructor Phillip Clay was promoted to the rank of Assistant Professor upon completion of his doctoral program, and Professors Ralph Gakenheimer and Richard Larson received tenure. Several faculty members were recipients of significant honors. Professor Frieden received a Guggenheim Fellowship to study national housing policy during 1975-76; Professor Lynch received an award from the AIP chapter of Southern California for his study of San Diego; Professor Rodwin was awarded the Churchill Fellowship and spent 1974-75 as an Overseas Fellow of Churchill College at the University of Cambridge, England. Professors Suzann and Leonard Buckle were awarded the Lilly post-doctoral teaching fellowship for 1974-75; Professor William Davis was awarded a Mellon Fellowship in the Humanities; Professor Ferreira was honored with the Class of 1922 Career Development Chair; Professor Hack won first award in Progressive Architecture's Awards Program for his study of The Night Environment and Ways of Improving It; and Professor Hubie Jones was named Social Worker of the Year by the National Association of Social Workers and received the Distinguished Public Service Award of the Boston University Alumni Association. The graduate students of the Department awarded Professor Robert
Fogelson and Visiting Professor Thomas Vietorisz, the Graduate Student Council award for excellence in teaching. Professor Vietorisz, from the New School of Social Research in New York, visited at M.I.T. for the fall term and will be here again next year under the auspices of the School's Ford International Visiting Professorship Program. A native of Hungary, he has had extensive experience in the field of international development. Coached by Professor Ferreira, Professors Larson and Willemain, Research Associate Keith Stevenson of the Department of Architecture, and Ph.D. students Pitu Mirchandani and Roger Dear of the interdepartmental Operations Program participated in winning the Operations Research Center Intramural Squash Championship.

Publications

Recent publications of the faculty include Professor Schon's Theory in Practice (Jussey, Bass, San Francisco, 1974) with Chris Argyis; Professors Suzann and Leonard Buckle's Bargaining for Justice (Prager Press, Special Studies, 1975); and Professor Polenske's Advances in Input-Output Analysis (Ballinger Publishers, Cambridge, Mass., 1975). Numerous articles and monographs also have been published during 1974-75.

Future Needs and Prospects

Despite the financial crises, we have survived the year. One might argue that we have done more than survive. There is an atmosphere of excitement in the Department about the new core subjects, about the consolidation and sequence of offerings. Our Ph.D. program is being scrutinized by people who are determined to make it the finest in the country. For all the diversity in the Department there is the feeling of good will, an acceptance of compromise, a commitment to try new things and to take responsibility to make them work. The climate is a positive one which bodes well for the future.

However, we have not reached the promised land.

In his final report, Professor Rodwin ended by emphasizing "that it would be a serious mistake to impose a strict moratorium on future growth of the Department of Urban Studies." While a central theme of the year has been one of self examination within a world of tightening financial constraints, Professor Rodwin's judgment remains valid. There are several areas -- environmental management and policy is one striking example -- where the needs of the society and the capacities of the Department merge in such a way as to require an expanded effort on our part. In an era when one's energy is seemingly consumed in the endless effort to find dollars to get over the next financial hurdle, it is often easier to say no to any effort to initiate a new subject, to hire a new person, to explore a new research opportunity. If we become obsessed with fiscal constraint and financial cut-backs, there is great danger that opportunities may be brushed aside which may in the long run prove not only academically, but also financially, fruitful. The chemical reaction between cost effectiveness and academic innovation is unclear, and we must undertake the experiment with caution.

We need to continue exploring ways of doing business with other departments. In an era of diminishing Institute resources, departments must complement rather than compete with one another. But "foreign affairs" negotiations are time consuming and complex. Joint appointments are one way to bridge the gap, but the pressures on people with such ties are severe. Cross listing of subjects is a necessary but not sufficient way of institution building. Our commitment to minority students, which has benefitted from major financial support from HUD, is placed in jeopardy because of shifts in Federal funding. Finding the resources to
maintain the program is a major commitment and a major problem. Inadequate space continues to be a preoccupation. The battle of offices, where, how many, and for whom, is a phenomenon which consumes much energy and good will.

The problems are serious and the means for resolving them not entirely clear. However, given our existing good working relationship with both the Dean and the Administration, we are confident that significant progress can be made.

LANGLEY C. KEYES

Laboratory of Architecture and Planning

The second year of activities for the Laboratory of Architecture and Planning was one of growth and promising development. The Laboratory was created in 1973 to foster research which would advance the state of the art in the theory and methods of teaching and in professional practice in architecture and planning. In addition to carrying on existing projects, several new research and service programs were begun with potentially significant payoff for the School of Architecture and Planning in terms of increased volumes of research and new developments in curriculum.

There were three new research projects administered by the Laboratory in 1974-75 with a total annual volume of nearly $700,000. In addition, there were the two projects already housed in the Laboratory, the Urban Ecology Study, headed by Professor Stanford Anderson of the Department of Architecture, and funded by the Ernest Grunsfeld Memorial Fund; and the Innovative Resources Planning Project for Urban Public Safety Systems, headed by Professor Richard Larson and sponsored by the National Science Foundation.

The new projects were the following:

1) The Architecture Education Study, under the general direction of Dean William Porter and Dean Maurice Kilbridge of Harvard, is a project devised by the eight east coast architectural schools to analyze existing approaches to architectural education and to develop new, more effective programs. Professor Julian Beinart of the Department of Architecture is one of the study directors. Funding for the study is from the Mellon Foundation.

2) The Overlap Project, funded principally by the Advanced Research Projects Agency of the Department of Defense and under the supervision of Dean Porter and Dr. Joseph Markowitz, is devising ways of making inferences from textual and numerical data bases and automatically restructuring the data on the basis of these inferences (and vice versa). This project -- an outgrowth of the Cambridge Project which was administered by the Office of the Provost and which had its area of application in the social sciences -- is administered by the Laboratory and is aligned with the field of planning.

3) The Urban Environment-Education Reform and Development Project, under the supervision of Professor Gary Hack and funded by the General Services Foundation, provided the context for two innovations in environmental design education. The Total Studio, cosponsored by the Departments of Architecture and Urban Studies and Planning and offered by Professor Tunney Lee, was an effort to provide an integrated multileveled, multidisciplinary design studio concerned with a real problem and involving real actors. Secondly, David Judelson, Assistant Director
of the Laboratory, prepared a study on the feasibility of a concentrated program in environmental design for midcareer professionals.

This was the second year in which grants were made from the Albert Farwell Bemis Fund to students and faculty from the School of Architecture and Planning for projects which were of particular interest and appropriateness to the Laboratory. Results from the first round of funding were generally very encouraging, particularly when seen in the light of educational development. The following projects have already had an important impact on the curriculum.

1) Six case studies in environmental design were prepared under the supervision of Professor Hack (D.U.S.P.) and were used during the fall term as the basis for a new subject which was well received. The cases simulated a varied set of experiences from the world of professional practice. The studies provided a forum in which to discuss complex issues such as dealing with the conflicting goals of multiple clients, motivations, experience, and responsibilities of the many involved actors, and the nature of professionalism.

2) Professor Lawrence Susskind (D.U.S.P.) and 16 students worked with a citizen group in Rockport on several critical planning issues facing the town. The resulting report was widely distributed and highly praised as a model approach to planning and university-community collaboration. Through careful monitoring of the process, we were able to develop some useful ways of analyzing and evaluating student learning in fieldwork situations.5

3) Professor Michael O'Hare (D.U.S.P.) with several graduate students began an analysis of national arts policies and the resulting patterns of costs and benefits among different population and income groups. This work has led to some new approaches and understandings of arts policies in this country, and it appears to be a promising field of inquiry.

This year the Steering Committee of the Laboratory made awards totaling $60,000 from the Bemis Fund to 21 projects submitted by faculty and students in the School. Among them were:

1) Planning and design for the restoration and adaptive use of an urban church by Ann Beha, a graduate student in the Department of Architecture;

2) A study of the Pequannock Watershed in New Jersey, directed by Professors Lee and Richard Britain of the Department of Architecture, which developed a novel approach to the design of a feasible housing environment which would maximize the use of solar energy, be sensitive to microclimate conditions, and have a minimal impact on the local ecology; and

3) The creation of strategies for large scale development in Rhode Island, directed by Professor Thomas Nutt (D.U.S.P.). Working with planners from the Governor's Office, Professor Nutt and several students analyzed the workings of several state planning agencies and recommended new substantive and administrative procedures which would enable Rhode Island to generate more efficient and thoughtful new development.

The last two projects also received funding from PACE (Planning Approaches to Community Environments, Inc.) which contributed money to eight school fieldwork projects which were oriented around land use planning.


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During the year, a small research program was initiated by the Laboratory in conjunction with the City of Cambridge. The program was modeled after the Urban Observatory Program sponsored by the National League of Cities and the U.S. Department of Housing and Urban Development. Professor Aaron Fleisher, with the assistance of Professors Gary Marx and Thomas Willemain, is analyzing a number of municipal service delivery systems in Cambridge, particularly the Police Department and the Neighborhood Health Services Program, attempting to develop useful measures for the output of services.

Professor Timothy Johnson of the Department of Architecture was awarded a grant from the National Science Foundation to continue the development and test a variable transmission membrane. This multilayered building panel has the properties of automatic solar heating and cooling control.

During the next 12 months we expect a number of outstanding research proposals to be funded by agencies outside M.I.T., thereby paying off on the initial "seed money" which the Laboratory provided. In addition, the Innovative Resources Planning Project, directed by Professor Richard C. Larson (D.U.S.P.), will become an official Laboratory project.

The Laboratory will continue to provide assistance to members of the School in their research and teaching activities. For field-linked activities, it performs a brokerage function among students, faculty, and outside client groups in the community and helps to evaluate the educational components of those activities. Computing services are provided by acquiring and maintaining software, and facilitating its use by means of documentation and special instruction. Services in support of research efforts include identifying potential sources of funding, providing consultation on the preparation of proposals, and administering Laboratory affiliated projects. The Laboratory promotes the integration of research into the educational environment of the School and the Institute by sponsoring lectures, seminars, conferences, a program of visiting fellows, publication support, and the maintenance of a small library.

A manual on the Laboratory currently being prepared, will describe the services offered by the Laboratory, the research and fieldwork projects in the School of Architecture and Planning, an index of resources in the School, lists of publications, and an overview of the Laboratory and its conceptual basis.

We also intend to begin a study which will help us understand more thoroughly the educational values of fieldwork in architectural and planning education and the possibilities that may exist for simulating real world experiences (which would normally be had in fieldwork situations) in the classroom. Professors Suzann Buckle and Leonard Buckle, codirectors of the Laboratory's Office of Field Services, are preparing to conduct this study which would compare student learning and supervised fieldwork, simulations of field settings, case studies, and traditional teaching on the theories of professional action.

Finally, we intend to reorder our priorities somewhat with respect to Bemis Fund criteria and awards. Because of the growth of the Departments' interest in research as integral to the development of the teaching programs in Architecture and Urban Studies and Planning, we plan to encourage the faculty to develop Bemis Fund proposals stressing more fully their projects' potential for innovating within the teaching programs, as well as the potential for attracting outside sponsorship and for advancing the state of the art in the fields of architecture and planning.

WILLIAM L. PORTER
The School of Engineering's development during the 1974-75 academic year must be seen against its primary goal of furthering the evolution of the engineering profession -- the state of the art in engineering and the foundations upon which the engineers build through research and education. The School's programs must be responsive to the needs of the engineering profession as the profession's scope broadens to encompass:

- the development of the engineering sciences and technologies;
- the process of engineering -- that is, the conception and development of reliable and economical technical solutions; and
- the process of planning responsible uses of technology as these uses relate to societal needs.

These three dimensions of the School's scope, as well as its development toward them as goals, were discussed in last year's report. This report of the School of Engineering highlights the continuation of these developments.

As part of the School's activities related directly to broadening the School's scope, three task forces -- Constructed Facilities, Manufacturing, and Materials -- were organized during summer, 1974. Each task force developed an overview of its respective field, pointing out societal needs, critical issues and problem areas, and trends judged to be most significant in terms of that field's future development; collecting and summarizing information on the Institute's current and planned education and research programs, resources, and interests related to the field; determining how each of these programs is related to the identified opportunities, highlighting those opportunities for education and research in which M.I.T., and particularly the School of Engineering, should make a worthwhile contribution to the technology and skills of the field; and recommending the alternatives available to the School in order that it capitalize on the research and educational opportunities identified. The reports of these task forces have been completed. Each presents major new opportunities for the School and argues forcefully for the orderly expansion of our activities in the respective areas. The recommendations from the reports will be considered in detail during the forthcoming year.

Last October, when it became increasingly clear that the financial problems of the Institute had reached serious proportion, even though departments have experienced significant budgetary reductions for the past three years, the involvement of the School's faculty and staff was sought in a process of self-appraisal. At that time, we noted that even as these financial pressures are faced, numerous opportunities exist for introducing important new teaching and research programs into the School. We also noted that if the School of Engineering is to maintain its position as this nation's leading engineering school, it must investigate carefully each new opportunity, determining the extent to which that opportunity is meaningful to the Institute and School. Since new programs invariably call for the commitment of additional Institute resources, the Institute and School face a dilemma.
The objective of this self-appraisal process was to determine action alternatives which would assure the intellectual evolution as well as the financial viability of the School. A number of panels, each with assigned responsibilities, and a coordinating committee consisting of the chairmen of these panels were established. In all, more than 100 members of the School's faculty and staff were involved in the process. The panels have completed their work and submitted their reports which contain upwards of 50 recommendations that are being synthesized into a final report to be distributed to the faculty early in the 1975-76 academic year. The recommendations deal with issues such as the academic and administrative structure of the School, the School's planning and budgeting process, the academic calendar, approaches to new educational and research programs for the School, and financial and student administrative processes.

One recommendation was the introduction of a program planning and budgeting process which would permit the integration of individual program elements in terms of priority, intensity, and cost. The process also permits the determination of costs for program elements during a program's execution. In order to react responsibly to the constraints of financial pressures and new opportunities for advancing our teaching and research programs, the School of Engineering is using this recommendation in the preparation of the budget for fiscal 1976. Preliminary discussions of the other recommendations have already occurred at Engineering Council, and further discussions with the Council and the School's faculty are anticipated for the fall.

Research

The scope of the research program carried out by students and faculty of the School has continued to broaden. It has retained its momentum in the basic fields and has gained a substantial momentum in multidisciplinary areas such as energy, transportation, and biomedical engineering. As a result, the research volume of the School has increased from $17.1 million for fiscal 1974 to an estimated $19.9 million for fiscal 1975, a 16 percent increase in the volume of sponsored research. Particularly noteworthy is the doubling in the research volume in the Department of Nuclear Engineering and the Center for Transportation Studies over the last year. The actual research programs of the School are described in the reports of the departments and centers. Here, only the evolutionary trend of this research program as it relates to the primary functions listed above will be noted.

The multidisciplinary, cooperative efforts by groups of faculty members are steadily increasing as illustrated by the following examples: faculty from the School of Engineering were instrumental in developing and conducting research programs in two research areas of the Institute's Energy Laboratory: nuclear, environmental, and electric power technologies; and fossil fuels technologies. Faculty from the School were also involved in the Laboratory's other two program areas, energy management and economics, as well as in its special projects. Under the auspices of the School's Center for Transportation Studies, a major effort was initiated to broaden that Center's research program, particularly by faculty from the Departments of Civil Engineering and Aeronautics and Astronautics, in cooperation with faculty from the Department of Urban Studies and Planning. As a result, the outlook for next year is particularly bright. New contracts for three major programs alone total $1 million for the next fiscal year, with many other proposals pending. Efforts of the faculty in biomedical engineering were rewarded by the receipt of an NIH National Research Service Award in Biomedical Engineering and by a grant from the National Institute of General Medical Sciences to the Harvard-M.I.T. Program in Health Sciences and Technology (H.S.T.). This grant is for the establishment of a biomedical engineering center for clinical instrumentation.
The School's faculty is actively seeking opportunities to increase cooperation with industry. The spectrum of present activities includes the following: a project on consumer durables (carried out at the Center for Policy Alternatives under the sponsorship of the National Science Foundation's Program for Research Applied to National Needs, RANN); energy-related projects (conducted in cooperation with utility concerns) by faculty and staff from the Departments of Electrical Engineering and Computer Science, Nuclear Engineering, Mechanical Engineering and Civil Engineering, and M.I.T. Energy Laboratory; the School's polymer processing, (initiated by Professor Nam P. Suh of the Department of Mechanical Engineering,) for coupling students with industrial research problems in polymer processing, and the construction program of the Department of Civil Engineering which has succeeded in obtaining five to six fellowships each year for students working toward their master's degrees on construction-related problems.

The School's international activities which are concerned with academic programs as well as with research are also increasing. In addition to the continuation of existing cooperative and exchange programs, such as those with the Technical University of Berlin and the Birla Institute of Technology at Piliani, India, the School of Engineering is participating in a new exchange program with the Arya Mehr University of Technology in Tehran, Iran, and in the exploratory planning for the establishment of a private institute of technology in Spain. Also, under an agreement with the Imperial Organization for Social Services of the Government of Iran, M.I.T. is participating as an advisor in the development of a new, innovative program aimed at the education of technicians as well as of teachers for technical schools. With this program, faculty of the School are exploring special innovations to advance this educational process. The school is also discussing with universities in other countries ways in which it can assist in the development of their engineering schools and the faculties for these schools.

Through the Center for Policy Alternatives, research programs concerning government policy as it influences the process of innovation and the infusion of technology were initiated with Brazil, France, Venezuela, West Germany, the Netherlands, and Spain. These studies were sponsored by the National Science Foundation and the governments of France, Brazil, and Venezuela.

The M.I.T. Technology Adaptation Program, funded through a grant by the Agency for International Development (AID) of the U.S. Department of State, is beginning to develop within the lesser developed countries the capability for planning meaningful uses of technology in specific applications -- for example, in the construction process. We expect that as this program continues, separate programs will be initiated with specific countries under either AID's or that country's own sponsorship.

Associated with these extremely important and exciting developments of the School's research program is a considerable increase in the faculty's efforts related to the development of proposals for new, multidisciplinary research programs. Many of these proposals require substantial background research and can be considered major projects in themselves. In many instances, this preproject activity, which is usually expected to be carried out on the margin, has created a substantial overload on our faculty.

Undergraduate Education

During the 1974-75 academic year, the undergraduate enrollment in the School of Engineering increased again, reaching a total of 1,330 upperclass students. This represents an increase of 62 over the 1973-74 academic year, and an increase of 162 over 1972-73. Numerically, this growth occurred primarily in the Departments of Electrical Engineering and Computer
Science, Mechanical Engineering, and Chemical Engineering. With 1,330 students, the School of Engineering enrolled 47.7 percent of all those M.I.T. undergraduates who had elected departments in the 1974-75 academic year.

The number of women enrolled in the School's undergraduate program was 106, or 14 more than in the preceding academic year. The total number of women in the School's undergraduate program is 7.2 percent of the total undergraduate enrollment in the School. There are 80 undergraduates of ethnic minorities, U.S. citizens of black, Spanish, or Oriental ancestry, in the School. Nevertheless, the School feels that more minority students, particularly blacks, could find rewarding, meaningful careers in engineering. In response to this, the School has explored and made proposals for the support of programs to introduce minority high school students to the excitement, intellectual challenge, and career opportunities which engineering offers. A special two-week summer program, Minority Introduction to Engineering, will be conducted by the School during summer, 1975, for 40 minority students as a first, determined effort in this direction. This program is sponsored by the Engineers Council for Professional Development with funds from U.S. industrial firms.

Recognizing that the dimensions, intellectual challenges, and career opportunities in engineering are hardly understood by high school students, the School conducted a special two and one-half day symposium in September, 1974, to which 112 science and mathematics teachers from high schools in the United States, Puerto Rico, and Canada were invited. The conference's objective was to expose the teachers to the thrust of modern engineering. The conference was successful, as responses from the teachers who attended indicate. Clearly, one of the best ways to present a strong image of engineering to high school students is through the science and mathematics teachers who have daily contact with them.

The efforts of the School's faculty to interact with freshmen and provide them with opportunities to see various facets of engineering and engineering education have continued successfully. A typical example of these activities was Professor Mildred Dresselhaus's seminar, "What is Engineering?" which attracted many students and provided perspectives on engineering and its various fields.

The School's undergraduate program is also experiencing an increase in student interest in "hands-on" operation and in exploring ways "to apply what is learned." This is illustrated by the increased involvement throughout the School in cooperative programs, the Undergraduate Research Opportunities Program (UROP), work-study opportunities, design-related subjects, and in the Innovation Program which the School is conducting on an experimental basis under the National Science Foundation's sponsorship.

An important accomplishment during the past year was the completion of the film, "Women's Work: Engineering." This film, which seeks to encourage young women to enter the engineering profession by showing vignettes from the lives of women students and women engineers, was produced by the Center for Advanced Engineering Study. It will be widely distributed during the coming year.

Graduate Education

The enrollment in the graduate programs of the School of Engineering increased from 1,556 students during the 1973-74 academic year to 1,621 in 1974-75, which is only slightly lower than the all-time high in graduate enrollment of 1,632 in 1965-66. This enrollment includes 64 women, two less than the preceding year; the number of ethnic minority students in the program increased from 68 in 1973-74 to 77 in 1974-75. The number of foreign students enrolled changed from 495 for 1973-74 to 525 for 1974-75.
During this past year, a special academic program was developed between M.I.T. and the Atomic Energy Organization of Iran based on a request to the Department of Nuclear Engineering. This special program calls for two groups of 27 Iranian students each to enroll in two-year Master's degree programs in Nuclear Engineering. The first group of students will begin in summer, 1976. Since the Nuclear Engineering Department could not absorb such a large number of students without the addition of new resources, the program is being conducted as a "special program" with full cost recovery. The program's purpose is to educate talented young Iranian scientists and engineers in nuclear technology, preparing them for careers in the Iranian nuclear industry.

A new program, Technology and Policy, was developed by a group of faculty under the leadership of the School of Engineering. Over the past years, the impacts of technology have become increasingly profound and pervasive. The analysis and synthesis of large-scale systems involving technology have more and more required that 1) traditional engineering disciplines be blended with those of economics, systems analysis, and other social sciences; and 2) the "software" of people, policies, and institutions be considered integrally with the "hardware." To meet the need for trained professionals to work in this area, a new Master's degree program, sponsored by the School of Engineering, has been developed and was approved by the Institute in the spring. Graduates from this program are expected to take positions in government and industry doing needs analysis, impact studies, technology assessment, and project evaluation as well as planning policies and configurations for large-scale technical systems of many kinds. Funds have been obtained from the Sloan Foundation to support curriculum planning and the first few years of pilot operation.

Faculty

The intensity of the commitment of the School's faculty in responding to new challenges and increasing demands is commendable. The frequent recognition of faculty members, listed in the reports from the departments and centers of the School, is visible proof of the faculty's unique professional stature.

The faculty of the School feels particularly honored that during this year nine of its members -- Professors Wilbur B. Davenport, Jr., Jacob P. den Hartog, Gerald P. Dinneen, John F. Elliott, W. David Kingery, Edward A. Mason, Warren M. Rohsenow, Robert V. Whitman, and David C. White -- were elected members of the National Academy of Engineering; that Professor J. Herbert Hollomon was elected a foreign member of the Royal Swedish Academy of Engineering Sciences; and that Professors John W. Cahn and Fernando J. Corbato were elected Fellows of the National Academy of Arts and Sciences.

During the year, Professor Myron Tribus joined the faculty as Professor of Engineering and Director of the Center for Advanced Engineering Study. Also, Professor Alan Altshuler has returned to the Institute with a joint appointment to the Departments of Political Science, Urban Studies and Planning, and the School of Engineering. In the School, he will be associated with the Center for Transportation Studies.

Professor Mason resigned as head of the Department of Nuclear Engineering and requested a leave of absence in order to become one of the commissioners of the newly established Nuclear Regulatory Commission. Professor Kent F. Hansen, executive officer of the Department of Nuclear Engineering, served as its acting head from February through June, 1975. He will be succeeded on July 1, 1975, by Professor Norman L. Rasmussen as head of the Department of Nuclear Engineering.
Professor Peter S. Eagleson asked to be relieved as head of the Department of Civil Engineering at the end of this academic year in order to take a sabbatical leave and then return to teaching and research in the Department. Professor Frank E. Perkins, who has been Special Assistant to the Dean of Engineering for Undergraduate Programs, will be acting head of that department during the 1975-76 academic year.

ALFRED H. KEIL

Department of Aeronautics and Astronautics

The Department has continued a high level of teaching and research activity, both in the traditional areas of aerospace as well as in others not usually associated with our disciplines. Work in stationary energy conversion systems and the analysis of total transportation complexes, including ground and air, and an active program in the physiology and psychology of man-vehicle interactions has complemented our usual activity in the design and development of aeronautical and astronautical systems and their components. A feeling of disenchantment with high technology endeavors, noticeable in the early 1970s, and apprehension about employment potentials in aerospace, resulted in unusually small sophomore classes during that period. A change is now evident, however, partly as a result of efforts by the Department faculty to make the teaching of the basic disciplines more relevant to their engineering applications, and by increased communication with all freshmen in order to clarify the need for high quality engineering. These efforts, together with a gradual realization by young people that excellent employment opportunities, particularly for our graduates, continue to exist in aerospace, have resulted in a gradual reversal of the trend in dropping enrollment, as evidenced by present enrollments in Course XVI and sophomore enrollments to date for next year. A similar trend is evident in graduate enrollment.

Course preferences of the entering freshman class indicate a continued upward trend, and it is hoped that the Department will soon stabilize at its desired level of 35 to 40 entering sophomores per year and a graduate enrollment of approximately 150.

A similar increase in special student enrollment is also evident, with 14 in 1972, 16 in 1973, and 23 in 1974. A large demand in the area for special student instruction exists, and the degree to which the Department can respond is limited only by available faculty.

Total research volume has continued its upward trend, with a 1976 forecast of $3.3 million, compared to $3.1 million in 1975 and $2.8 million in 1974. However, the actual increase in research generated by the Department is larger, since a substantial amount of research is now administered outside the Department in the special laboratories, in particular the Energy Laboratory, the Transportation Center, and the Research Laboratory of Electronics. The true volume of research generated by Department faculty will be close to $4 million in 1976.

Several innovative concepts in undergraduate education have continued in the Department during this year. The Unified Engineering program, now in its second year, is currently being restructured on the basis of experience to date. The subject is extremely successful, popular with the students, but faculty intensive. It is hoped that as a result of the restructuring process other departments interested in this approach to the teaching of the disciplines of engineering could become more easily involved in the subject. The disciplines are dynamics, thermodynamics, solid mechanics, and fluid mechanics. During the past two years they have been taught in a unified format and related directly to applications in engineering, so that the need for the discipline can be understood in the context of its application. We are now exploring the possibility of structuring the teaching of these disciplines so that students may enter and leave the program more easily than in the past.
Hands-on experience is given priority in the Department and has been available through several offerings. The UROP program, in which the Department has been particularly active, had 14 students involved. Undergraduates are designing, testing, and building BURD II, a man-powered aircraft for the Kremer competition. The penultimate sailplane program provides experience for undergraduates in design, testing, and manufacturing using the advanced composite materials. Finally, mention should be made of the Innovation Center which continues as a fruitful experiment in the teaching of invention and entrepreneurship. Several projects have already reached the stage of commercialization, the eventual goal being a self-supporting operation when the National Science Foundation support ends. All indications are that the program will reach its goals and provide a valuable educational tool to the Institute and to the nation for the encouragement of technological innovation.

The Department continues to be fortunate in the quality of its undergraduate student body, not only from an academic viewpoint but from the community spirit and interest in departmental activities evidenced by our students. Val Heinz again received the Compton Award, not only for his services to the Department but to the Institute as a whole, and Thomas Stagliano received the Gold Award and the Pettigrove Award for his contributions to the athletic program.

The Department made the following awards: Henry Webb Salisbury Award for outstanding academic achievement to David Bradley Stuart Smith; Luis de Florez Award for "original thinking or ingenuity" to Val M. Heinz, David P. Maass, Milton Ortiz, and John H. Wendell.

The student chapter of the American Institute of Aeronautics and Astronautics (AIAA) in the Department has provided midway activities, undergraduate social occasions, and the Visiting Committee steak fry.

Departmental teaching and research activities may best be illustrated by the following brief descriptions of the various divisions of instruction.

**Aeronautical and Astronautical Systems**

Activities in this division center primarily in the area of space systems engineering and in air transportation systems, the end goal being the integration of the basic disciplines of aerospace and their application to the design and analysis of operating systems. Concern is not only with the vehicle, be it spacecraft or aircraft, but with the total supporting system including ground facilities, interaction with other systems, economics, and societal impact.

In air transportation, for example, consideration is given to the aircraft and its economics, to the airport and its access modes, to the demand analysis for the market being served, and to the impact of the airport on the community.

In space systems engineering, space-based energy systems provided the topic for the graduate systems subject last year, including a comparative study of various proposed concepts evaluated against earth-based systems. The subject was not given this year. Next year it is expected that a study will be made of space manufacturing, including possible colonization of a permanent base.

In the area of research, the Flight Transportation Laboratory has continued its active cooperation with the Transportation Research Center of the Institute as well as developing several new programs within the Department. A highly successful summer workshop was conducted for the National Aeronautics and Space Administration (NASA) on "Lighter than Air Technology" and was attended by over 300 people from Germany, France, England, Canada, and the U.S. Work has continued on advanced air traffic control concepts, including a situation display for terminal area operations of commercial aircraft and a low-cost navigation device for general
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aviation. A series of computer programs has been developed for the Federal Aviation Agency (FAA) to estimate air traffic delay by time of day at major airports around the U.S. New programs for next year will include demand analysis in aviation forecasting for NASA, and continuing work on air traffic control systems, intercity transportation, and alternative policies for national transportation. The Laboratory is also working with Nassau County and New York Airways in the study of potential uses of air in very short haul areas and as part of the total transportation system. Work will continue on noise impact and tradeoff design studies to reduce the acoustic signature of vertical takeoff and landing (VTOL) and short takeoff and landing (STOL) aircraft.

Energy Conversion and Propulsion

This division is involved in research and teaching in aircraft and spacecraft propulsion and in problems of stationary power generation and advanced energy conversion systems. Teaching and research in the division are heavily interdepartmental. Because of its involvement with gas turbines, fusion plasma physics, and magnetohydrodynamics (MHD) power generation, the division supervises several thesis students from the Departments of Nuclear Engineering, Physics, and Mechanical Engineering. Some of the division's research is conducted through the Energy Laboratory, including programs in coal-fired MHD, fossil fuel utilization, fluidized bed combustors, modeling of power systems, and combined cycles. Some 20 separate research programs are conducted in the Gas Turbine and MHD Laboratories, dealing with MHD lasers, closed-cycle MHD power generation, analysis and computation of the aerodynamics of turbomachinery with particular emphasis on three-dimensional flows, problems of noise generation and absorption, and basic studies of turbine blade cooling. The Laboratory for Plasma Physics and Space Science continues active research in cooperation with the Department of Nuclear Engineering on the transport theory for highly ionized plasmas in toroidal discharges (Tokamaks) in various temperature and density regimes. Interest is focused on the effects of impurities, inertia, self-consistent magnetic fields and currents, viscosity, anisotropics, and spin-up instabilities.

Some research highlights in MHD for the year include the development of a theory of interelectrode breakdown in MHD generators, which is tentatively verified by experiments in the U25 at the High Temperature Institute of the USSR; and a predictive theory of closed-cycle MHD generator behavior which for the first time satisfactorily explains the characteristics of these devices. In the gas turbine area, a detailed time-resolved study by fluorescent gas visualization and pressure measurement of the flow field of a transonic compressor rotor was completed. Techniques for correlation of heat transfer in film cooled turbines were developed. Important features of the flow in highly loaded compressor rotors by an improved linear theory have now been explained. In the fusion area, the diffusion theory of multi-ion species plasmas in toroidal magnetic fields has been worked out and then applied to the crucial problem of a particle transport in fusion reactors.

Mechanics and Physics of Fluids

Decreased enrollment, coupled with the transition between earlier program requirements and those associated with the Unified Engineering program, led to a number of electives being offered as reading courses. However, with the expected increase in enrollment, this division will once more be able to continue its broad offerings. In aerospace studies, a jointly taught subject, Introduction to Aerospace Technology, was initiated and was highly successful. It
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will be continued as an introductory subject in the department to replace the old 16.81 and 16.83 combination.

All graduate students in the division now participate in two-hour research seminars each week in which thesis problems, procedures, and results are presented and subjected to critical comment.

In the area of research, studies of interactions of gases with solid surfaces continued in the molecular beam laboratory to determine the chemical interaction induced by oxygen impinging on a graphite surface. A second area is the study of the interaction of water vapor with ice nucleating surfaces, with the end aim being a better understanding of the formation of ice crystals in the upper atmosphere.

In the Fluid Dynamics Laboratory, work has continued on a study of nonlinear wave propagation instability, turbulent shear flows, sonic booms, rotating flows, the stability of vortex rings and other vortex systems such as may be generated by helicopter rotors, isotope separation, and, finally, bird flight in an attempt to understand the apparent high efficiency of bird propulsion.

In the Aerophysics Laboratory, the plasma wake simulator was used in the supersonic wind tunnel to map the electron density and Mach number distribution in ionized supersonic near wakes, in order to understand the effect of the ionized wake on microwave antennas. Work also continued on the measurement of aerodynamic forces on rotating bodies using the magnetic balance.

Structures, Materials, and Aeroelasticity

The division continued its teaching program in the subjects of finite element analysis, shell theory, structural dynamics, fatigue, and design with advanced composites. These activities were extended to include application of such techniques to other than aerospace problems. In particular, the division has been cooperating with the Department of Nuclear Engineering in teaching structural design of nuclear reactors. The division has also continued to explore the possibilities of coordinating teaching in structures among the Departments of Civil, Mechanical, and Ocean Engineering, at both the graduate and undergraduate levels. Graduate teaching in shells, finite elements, plates, and structural dynamics is now coordinated between these departments.

Most of the research in this division is conducted in the Aeroelastic and Structures Research Laboratory where research activities include studies of nonlinear divergences in stall flutter. Limit cycle oscillations as large as $\pm 90^\circ$ were observed experimentally. A gust generator has been developed for the Wright Brothers Wind Tunnel which is currently being used in a study of the stability and gust response of a tilt rotor configuration model and will be used to study responses of wind energy conversion systems to large-scale gusts. Studies are continuing on helicopter vibratory airloads, including nonpotential effects during close blade vortex interaction, both on the blade and on the vortex itself. The use of feedback control limiting the amount of wing vertical bending and rotor flapping induced by turbulence on a tilt rotor airplane is being investigated both analytically and experimentally.

Studies of wind load effects on, and wind environmental conditions around, ground structures are being continued both in the Wright Brothers Wind Tunnel and by actual measurement on a full-scale building where pressure, accelerations, and displacement are being monitored. As the result of a recent failure of a controllable pitch (CP) propeller on a Navy ship during
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maneuvers, a failure and safety analysis of CP propellers was conducted by an interdepartmental team, with the laboratory's primary responsibility being the dynamic and flutter analysis of the propeller blade. A study was conducted for the Air Force on the risk assessment of current damage tolerance criteria, accounting for the effects of random loading and initial size of crack damage. Based on the risk analysis results, several suggestions for modifying damage tolerance criteria were developed. Several finite element codes were developed and employed to compute stress intensity factors induced at cracks in common aircraft structural components.

Work on structural deformations produced by impulsive loads are being studied both theoretically and experimentally. One of the aims of this work is to achieve a higher level of safety in the event of the rupture of high-speed rotating machinery in both stationary power generating plants and aircraft engines. This important work is now achieving national recognition and is being extended to investigate various classes of typical tornado-driven objects which threaten protective structures, including nuclear power plants.

During this past year, computer codes, such as a versatile modular static loads, finite element code (FEABL-2), were developed in the laboratory and copyrighted by M.I.T. These have been acquired by many users. As a pilot project, the laboratory provided a short training program in the use of FEABL-2 for industry, educational institutions, and government agencies now using it. Extensions of this capability to include vibration analysis and transient response predictions are anticipated in the near future. This added capability will then be available to interested organizations under similar copyright licensing arrangements.

Instrumentation, Guidance, and Control

This division continues to attract the largest single group of graduate students and now represents 42 percent of graduate activities compared to 33 percent the previous year. In addition, there appears to be a sizable demand by industry in the Greater Boston area for educational services in the disciplines covered by this division. Preliminary discussions have been held with local companies regarding the possible offering of subjects at locations convenient to their employees. These subjects, taken one at a time by engineers continuing full-time employment, will be sufficient to allow the student to leave his or her work for one semester to write a thesis completing requirements for a Master's degree at M.I.T.

An innovation this year was the introduction of more systematic instruction in the area of computer applications to aerospace. To this end, a small PDP-11 facility will be developed later this year, allowing direct student participation in the design and operation of, for example, a computer-driven control system. This digital computer facility will be used in conjunction with the analog computer facilities in the department, as well as with experimental facilities and special project equipment.

The division has continued its participation in both the Program in Health Sciences and Technology (H.S.T.) and its own physiological and psychological teaching. A new subject was developed which demonstrated that the basic principles of human physiology can be taught successfully to engineers in a manner which is interesting to them and also takes advantage of their analytical backgrounds.

Research in the division is conducted in the Charles Stark Draper (C.S.D.) Laboratory, the Man-Vehicle Laboratory, the Laser Systems Laboratory, and the Measurement Systems Laboratory. The C.S.D. Laboratory provides a major portion of the support, offering fellowships in space vehicle control, inertial guidance systems, and advanced navigation
Faculty Activities

Professor Eugene Covert continued to chair the Undergraduate Committee, and Professor Wallace E. VanderVelde completed a two-year tenure as Chairman of the Graduate Committee, turning over the office to Professor Harold Wachman for next year. Professor Walter Wrigley chaired the interdepartmental doctoral program in Instrumentation. Professor John Dugundji chaired the doctoral committee, and Professor Henry Whitaker continued supervising the Engineer's degree program and serving as chairman of the Freshman Orientation Committee. Professor Winston Markey organized an interesting series of departmental seminars, culminating in a NASA presentation on space colonization concepts. Manuel Martinez-Sanchez, a Research Associate, assumed major responsibility for the Experimental Projects Laboratory.

Professor Sheila Widnall was on leave of absence in Washington, D.C. as Director of University Research for the Department of Transportation. In June, she was honored with the 1975 Achievement Award of the Society of Women Engineers.

Professor Leon Trilling was on leave of absence at Delft Technical Institute and presented a series of lectures in Europe. Professor Theodore Hsueh-Huang Pian spent this year in
Japan, the People's Republic of China, and at the Technical University of Berlin, presenting a series of seminars in the three countries he visited. He has also reviewed work being conducted in both Japan and Germany on the structural design of reactors. He is currently serving as a member of the International Scientific Committee of the Third International Conference on Structural Mechanics in Reactor Technology, to be held in London later this year. Professors Covert and Jack Kerrebrock were elected Fellows of the AIAA. Professors James Mar, John McCarthy, Covert, and Kerrebrock served with distinction on the Air Force Scientific Advisory Board. Professor McCarthy participated in a study which was instrumental in changing Air Force policy on basic research from one of in-house participation to that of sponsoring basic research in universities and nonprofit centers through the Air Force Office of Scientific Research (AFORS). Professor Kerrebrock chaired an Ad Hoc Committee on Air Force Energy Needs which prepared recommendations based on fuel conservation. Professor Laurence Young has been maintaining close relations with the Harvard Medical School and has been appointed a Lecturer in Engineering at that school, in addition to direct cooperation through the H.S.T. committee chairmanship.

Under the US-USSR cooperative program, Professor Jean Francois Louis proposed a joint program to determine the interelectrode breakdown in the Soviet MHD power generation facilities and was present at the initial series of experiments in Moscow, in March, 1975.

Professor Vander Velde continued his supervision of student research on advanced computer controlled manufacturing techniques in the Fiat Turin plant, and also was responsible for the academic programs of a group of engineers from Taiwan interested in hands-on experience with high technology.

Professor McCarthy assumed full-time directorship of the Space Center, relinquishing most of his teaching activities in the Department. Professor Dieter Sigmar transferred to a full-time appointment in the Department of Nuclear Engineering. Professor David Oliver resigned from the faculty, but will continue next year as a Research Associate.

R. H. MILLER

Department of Chemical Engineering

The Department continued to update its graduate programs, the new building neared completion, and additional stress was placed on cooperation with industry. Undergraduate enrollment increased by over 20 percent, while the entering graduate class grew over ten percent. Enrollment in the School of Chemical Engineering Practice reached a record high for recent years.

Undergraduate Program

The faculty implemented changes in the undergraduate curriculum intended to make the introductory subjects more appealing and to avoid duplication of material covered by subjects in the Department of Chemistry. A new two term sequence of sophomore-level subjects (10.13 Mass and Energy Processing, and 10.14 Thermodynamics) was offered for the first time by Professors Richard G. Donnelly, Michael Modell, and Warren D. Seider, replacing three subjects previously offered in the Department of Chemistry and Chemical Engineering. About 60 students enrolled in each of these subjects. A new freshman-level subject was developed (10.07 Introduction to Polymer Chemistry). Undergraduate enrollment jumped to 126 from 104 the year before.
This year, end-of-term student and faculty evaluations were required for all subjects offered by the Department. Each student was given a written evaluation by the instructor on the student's performance in the subject to supplement the letter grade and provide more feedback. The instructor was evaluated by students in the class using a standard evaluation form. The results were used by the Department to further the continuing efforts to improve the quality of instruction.

Graduate Program

The entering graduate class for 1974-75 contained 77 students -- the largest in more than 15 years. Ten new students started their doctoral programs.

The School of Chemical Engineering Practice, in which students spend one term working in industry under resident faculty supervision for academic credit, continues to be an important component of the graduate program in Chemical Engineering. Forty-three students elected the Practice School program during the year. This is a somewhat larger group than in recent years and is indicative of increased interest at the graduate level in engineering applications.

At the Oak Ridge Station, diverse projects were undertaken by students. Studies were made on various solar and geothermal energy collection and storage systems; supporting work for Liquid-Metal Fast Breeder Reactor (LMFBR), High Temperature Gas-Cooled Reactor (HTGR), and Molten Salt Breeder (MSBR) programs was undertaken; and mass transfer studies on open bubble columns were completed. In addition, students studied aspects of nuclear waste disposal systems for large coal-fired power plants, and the correlation of the resistance of plants to disease and insects with the presence of naturally occurring phenolic compounds.

During the past academic year, Professor Edward W. Merrill led the organization of a new program in polymer chemistry, assisted by Professor Robert E. Cohen. In addition to offering polymer seminars in both the fall and spring terms, at which distinguished outside polymer scientists were invited to speak, four completely new graduate subjects in polymers were offered for the first time in a coordinated program of instruction. One of these subjects, Compounding and Processing, was developed by Professor Merrill; another, Molecular Interpretation of Viscoelasticity, was developed by Professor Cohen; a third, Network Formation in Polymers, was developed and given jointly by Professors Merrill and Paul Rempp, Visiting Professor from the University of Strasbourg and the Center for Macromolecular Research in Strasbourg; and the fourth, Advanced Polymerization Processes, was given by Professor Rempp. Five students from the first year's operation of this program received their certificates of participation in the program from the Department of Chemical Engineering in connection with the Master of Science degree awarded at June Commencement.

Professor Donnelly has developed a new sequence covering surface and colloid chemistry on the graduate level to be offered for the first time during 1975-76. The first subject, 10.611 Physics and Chemistry of Surfaces, is an introduction assuming no background in surface chemistry. A novel feature of this subject is that it is self-paced, with students covering the material in as few as eight or as many as 20 weeks. The development of 10.611 was supported in part by the Lilly Foundation Post-Doctoral Award to Professor Donnelly. The second subject in the sequence, 10.612 Advanced Topics in Surface and Colloid Chemistry, will discuss recent experimental and theoretical advances, while emphasizing applications in chemical engineering.
Professor Donnelly has completed the final two study guides to accompany the series of video lectures on surface and colloid chemistry by J. T. G. Overbeek. The study guides are textual material covering the subjects of the various lectures and present solved problems for each.

Professor Donnelly has established a video laboratory within the Department, the facilities of which include a portable video cassette recorder/player, a portable recording and playback monitor, a portable color camera with ability to record under low-light (classroom) conditions, and a viewing area which can accommodate two to three persons. The video laboratory facilitates self-study with the playback of prerecorded tapes in the viewing area; supplementation of classroom teaching by using prerecorded tapes of remote locations; and recording at remote locations of special lectures, student presentations, and normal faculty lectures. These capabilities aid in the improvement of teaching and in student presentations for practice, demonstrations, experiments, etc.

The M.I.T. Sloan Fund continued to share the support of Professor Cohen's Polymer Science Laboratory.

The Chemical Engineering Real-Time Computing Facility, under the able direction of Professor Lawrence B. Evans, continued to support Departmental research activities and provide educational experiences for Chemical Engineering students.

The Department participated in the activities of the Innovation Center, established by the School of Engineering. Interdepartmental subjects 10.801J Entrepreneurship and 10.802J Invention were offered under the direction of Dr. Ogden Hammond, Lecturer in the Department.

Subject 10.58J Artificial Internal Organs was presented by Professor Clark K. Colton in association with the Program in Health Sciences and Technology. Professor Manson Benedict of the Department of Nuclear Engineering taught 10.79J Nuclear Chemical Engineering.

Donald B. Anthony was appointed Assistant Professor and Director of the Bound Brook Practice School Station.

At the senior level, the Department was fortunate in having a number of outstanding visiting professors this year, including Professor Paul J. Flory of Stanford University, Professor J. T. G. Overbeek of the University of Utrecht, Professor J. R. Anthony Pearson of the Imperial College (London), Professor Rempp of the University of Strasbourg (France), Professor John P. Longwell of the Exxon Research and Engineering Company, Professor James E. Mark of the University of Michigan, Professor Seider of the University of Pennsylvania, Professor James M. Douglas of the University of Massachusetts at Amherst, and William C. Rousseau of the Badger Company.

Research

Research volume remained steady at about $1 million for the third straight year. Interest by the Federal government in problems of energy, environmental protection, and resource conservation has provided new opportunities for funding chemical engineering research, and it is anticipated that the volume for fiscal year 1976 will increase.

In addition, the Department has placed additional stress on obtaining research money from industry or from government-sponsored industry-academic research. It is expected that the fruits of these efforts will be seen over the next few years. It is possible to list here only some representative examples of research being carried out in the Department.
Research in the Fuels Research Laboratory, under the direction of Professors Glenn C. Williams, Adel F. Sarofim, Jack B. Howard, and Lloyd A. Clomburg, covered the fields of combustion, generation and destruction of pollutants, carbon black formation, heat transfer and mixing in glass furnaces, radiative heat transfer, fire research, coal pyrolysis and gasification, coal combustion and ash behavior in magnetohydrodynamics (MHD) combustors, and solid waste incineration. Major inputs were provided by Professors Emeriti Hoyt C. Hottel and Herman P. Meissner, by Visiting Professor J. P. Longwell, and by Assistant Professor Ronald A. Hites.

Professor Modell, in collaboration with Professors Donnelly and Robert C. Reid, was engaged in several projects concerning treatment of wastewater. In addition, Professors Reid and Modell are exploring conversion of organic wastes to high Btu gas, using hydrogenation and reforming catalysts at or near the critical conditions for water.

Professor Charles N. Satterfield has continued his research in catalysis, applied kinetics, reactor technology, and industrial chemistry.

Professor Kenneth A. Smith has continued his activities in the fields of fluid mechanics and heat and mass transfer, with special application to drag reduction, liquefied natural gas (LNG) technology, desalination, and biomedical transport. The drag reduction studies have focused on the elongation of macromolecules in a pure straining field and are the first of their kind. These have been done in conjunction with Professors Merrill and Robert C. Armstrong. The LNG studies are directed toward possible electrostatic effects and the role of stratification in large storage tanks. The biomedical transport work is concentrated on topics which are relevant to arteriosclerosis and is being carried out jointly with Professor Colton. The studies are directed toward the mechanisms by which cholesterol and low-density lipoprotein infiltrate the arterial wall.

Professor James H. Porter's research on coal utilization has included studies of advanced power cycles, high temperature desulphurization, fluidification of sticky coal with iron addition, and coal liquefaction using paper pulping solution.

Professor Armstrong has been studying the rheology of dilute polymer solutions by modeling the physical behavior of individual macromolecules in solution. Professor Cohen has conducted an experimental investigation of the mechanical and rheological properties of bulk polymers and theoretical studies of polymer viscoelasticity.

Professor Meissner has continued his studies of the activity coefficients of strong electrolytes in solution.

Professor Hites has continued his research into the application of analytical chemical techniques to the solution of environmental and energy-related problems. A major effort has been concerned with identification and quantification of industrial organic pollutants in the Charles, Merrimack, and Monatiquot Rivers.

Professor Evans has continued his work in the fields of process dynamics and control, and computer-aided design. His research has focused on the dynamics and control of a cyclic absorption system, a methanation reactor, and a biological system.

Professors Evans and Porter, in collaboration with Professor Seider, have been planning the development of a computing system for process engineering. They system, tentatively named Integrated Energy Process Engineering System (I.E.P.E.S.), would be used in the study of systems for energy conversion and conservation and would be developed with the close cooperation of industry.
Professor Donnelly continued his research in surface and colloid chemistry and heterogenous catalysis. He is also studying the mutual solubilities and phase equilibria of methanol-gasoline blends.

Professor Michael Mohr developed economic models of solid waste disposal alternatives.

Professor Colton has been active in the areas of biomedical transport and enzyme technology. Efforts in biomedical transport have been in collaboration with Professor Smith and are largely motivated by arteriosclerosis. In particular, current studies are attempting to develop an understanding of the rate and the mechanism by which cholesterol and low-density lipoprotein infiltrate the arterial wall.

Professor Colton's research in the area of biochemical engineering centers on the development of a fully enzymatically catalyzed scheme for the regeneration of the high bioenergy molecule adenosine triphosphate (ATP), utilizing novel designs of immobilized enzyme reactors. These systems are to be coupled to the enzymatic synthesis of such antibiotics as Gramicidin S and Bacitracin A. His investigations not only include work on enzyme reactor design and analysis, but also on the isolation, purification, and analysis of the kinetic behavior of the relevant enzymes. Prior research in enzyme technology has focused on the use of enzymes to produce merely degradation products.

Professor Reid has continued his research on high temperature liquid heat capacities and the kinetics of the Bosch Process.

Professor Merril, aided by Professor Cohen and Dr. C. S. P. Sung, has directed a major research program on nonthrombogenic biomaterials in conjunction with Dr. Edwin Salzman of the Beth Israel Hospital, Boston, and Professor David Waugh of the Department of Biology. He has also joined Dr. John P. Trump, Professor Emeritus of Electrical Engineering, and Dr. Anthony Sinske, Professor of Biochemistry, in the direction of a major program, sponsored by the National Science Foundation, on the electron irradiation of waste. This program will culminate in the construction of a pilot plant at Deer Island, Boston, to demonstrate the feasibility of decontamination of sewage by irradiation.

Dr. Hammond continued his research on novel coal gasification schemes, computation of equilibria in coal gasifier systems, and novel fuel cells, as well as research and development work at the Innovation Center on determination of the purity of gold ingots and gas nucleation cleaning processes. He also is supervising, with Professor Michael J. Driscoll of Nuclear Engineering, the development of an enrichment process for uranium found in Dakota lignites.

Industrial Interactions

The LGN Research Center is funded by the American Gas Association and its research is directed by Professors Smith and Reid. There are five major research areas: 1) LNG gels; 2) vapor explosions; 3) heat transfers; 4) electrostatics; and 5) roll-over in LNG storage tanks.

A research program in the design of glass melters was initiated in the late 1960s with the support of Owens-Illinois, PPG Industries, and Brockway Glass. Close contact has been maintained with the industrial companies, through meetings at M.I.T., plant trips by the students, and through delivery of computer decks to the sponsoring companies. The National Science Foundation is now supporting the research as an example of industry related research.
Contacts with industry are provided through biannual meetings with an industry committee. The general mode of collaboration is one in which M.I.T. develops the methodology and industry applies the design tools to their specific problems.

Under support of Armour Pharmaceutical Company, licensed under M.I.T. patents resulting from Professor Merrill's research, further research on lecithin aerosols has been carried out at Beth Israel Hospital. Findings from the team at Beth Israel, under Dr. John Hedley-Whyte, indicate that the lecithin, when delivered by an aqueous aerosol to the lungs of rats, is in fact deposited primarily in the alveoli of the lungs, thereby convincingly demonstrating what heretofore has been an hypothesis.

Visiting Professor Longwell taught 10.39 Energy Technology, with substantial industrial input. He also assisted in the preparation of a number of research proposals, including joint M.I.T.-Exxon proposals in the coal utilization area.

New Chemical Engineering Building

The new Chemical Engineering Building will be completed about December, 1975. Funding for this much-needed building was obtained exclusively from private sources such as corporations, individuals, and foundations. The generous alumni response was very encouraging.

With the current national emphasis on energy research and related areas, it is suitable to consolidate and expand M.I.T.'s Department of Chemical Engineering. The completion of this new facility will make it possible to accommodate the expanded research and teaching contribution that M.I.T. should make to a national effort.

The projects mentioned briefly here are only examples of the Department's extensive research, ranging from gas absorption to process control and from desalination to enzyme technology.

The Department notes with sadness the deaths of Professors Emeriti Warren K. Lewis and William H. McAdams.

RAYMOND F. BADDOUR

Department of Civil Engineering

The scope of civil engineering has been expanded to include the assessment of need for specific technology and the evaluation of its physical and social impacts. The Department faculty believe that education for leadership roles in such an expanded profession can best be carried out within an organization which is structured to address the full range of technical, economic, social, political, and management issues encountered in providing society with its essential functions. Within the traditional scope of civil engineering, these societal functions include transportation and construction. However, civil engineers also have a long-standing interest in the issues of resources and environment connected with satisfying these and other needs of society.

Over the last decade, we have developed this broadened concern in transportation and in the water resources and water environment areas.
Effective July 1, 1974, we combined the Department's former Materials, Structures, and Geotechnical Divisions into the new Constructed Facilities Division, under the leadership of Professor William A. Litle. Our motivations for seeking this change may be summarized as follows:

1) To create a more receptive format for functionally oriented education and research in the construction area.

2) To provide internal and external visibility for our activities vis-a-vis the construction industry and the problems of construction.

3) To realize the potential synergism of the three former Divisions.

4) To provide a framework for the systematic assessment of construction technology and for the development of policy alternatives for the construction sector of our economy.

The other two Divisions are as before, Water Resources continuing under Professor Donald R. F. Harleman, and Transportation now under Associate Professor Joseph M. Sussman.

The quality of these functional efforts and their uniqueness as M.I.T. activities depend critically upon first-rate inputs from the contributing disciplines such as mechanics, systems analysis, economics, and social science. Quite often, however, the pragmatic demands of the functional orientation come into conflict with the scholarly requirements of disciplinary excellence. We must therefore have an independent mechanism for the nurturing and monitoring of disciplinary capability. We hope to provide this by our creation of three disciplinary Groups, orthogonal to the three Divisions. These are Physical Systems, under Professor Jerome J. Connor, Systems Methodology, under Associate Professor David H. Marks, and Social and Management Systems, under Professor Marvin L. Manheim.

To help adjudicate the inevitable (in fact, intentional) competition for resources among the Divisions and Groups, and to advise the Department Head on operations and policy, we have created a Departmental Council consisting of the three Division Heads, the three Group Leaders, and the Chairmen of the Graduate and Undergraduate Committees. The Department Head acts as Chairman of the Council.

We believe this new arrangement will help us to insure that our graduates are equipped for a world of rapid changes.

Research

Infrastructure and resource development studies for developing countries are becoming an increasingly important part of the Department's sponsored research effort. The descriptions of several of these projects follow.

Evaluation Framework for Transportation Planning in Developing Countries

Sponsored by the Agency for International Development (AID), and under the direction of Professor Fred Moavenzadeh, this project seeks to assist developing countries and donors of assistance funds to better understand the relative merits of alternative possibilities for highway
construction, taking into account certain social and national costs and benefits, including the conventional economic factors. The specific objective is to develop an evaluation framework for use in analyzing and assessing the consequences of various highway projects and their alternatives. The work will focus on Ethiopia, and emphasis will be placed on identifying, clarifying, and resolving major issues of highway planning, programming, and budgeting in that country. To the extent possible, costs and benefits will be quantified and results will be generalized for broader application.

Strategies for the Development of the Sahel-Sudan Region of Africa

In January, 1975, the multidisciplinary team led by Professor William W. Seifert concluded its study of West Africa. The team included Professor Paul O. Roberts and Associate Professor David C. Major, as well as Professor John B. Stanbury of the Department of Nutrition and Food Science and a number of research associates, research assistants, and full-time research staff members. Several faculty members from the University of Arizona also participated. The end product was a 12-volume series which examined the agricultural potential of the region; economic considerations influencing development; the role of health, nutrition and population factors; the potential for industrial development; the influence of social and political factors; the potential impact that new technology and institutional development might have; the role of transportation; and the possibilities for energy and mineral resource development. One volume was a listing of library holdings and organizations that were contacted during the project.

The project was conducted through the School of Engineering's Center for Policy Alternatives and was funded by the U.S. Agency for International Development. The final report represents a major contribution to the type of broad understanding which is becoming increasingly necessary if assistance to the third world countries is to lead to true long-term development rather than merely to the minimization of immediate suffering.

Tunnel Cost Model

In an attempt to improve the treatment of uncertainty in tunnel cost estimates, a Department research team has developed a Tunnel Cost Model, which quantitatively assesses the technical uncertainties inherent in underground work and is detailed enough to aid in preparing estimates or bids. The research effort, funded under a grant from the National Science Foundation's Research Applied to National Needs (RANN) program, is headed by Professor Moavenzadeh, assisted by Associate Professor Herbert H. Einstein.

Briefly, the model employs techniques of subjective (or "degree of belief") probability and Monte Carlo simulation of tunnel construction operations to estimate distributions of construction costs and completion times. The spread in these distributions indicates the relative uncertainty inherent in the tunnel estimate.

The model accounts for two primary sources of uncertainty: 1) the description of geologic conditions; and 2) the estimation of costs and advance of construction operations. It is limited in scope to hard-rock tunneling.

To follow as closely as practicable the actual estimation-to-construction process practiced by contractors, estimators, and engineers today, the model is divided into three major parts or submodels: the geologic submodel, the construction submodel, and the tunnel simulator.
The geologic submodel processes information normally available to a project geologist; the construction submodel reads user information on construction methods and procedures to be used under the different geologic conditions; and the tunnel simulator assembles the information produced by the two other submodels to compute total project cost and duration.

Screening Models for Plan Formulation

With the joint support of the Office of Water Resources Research and the Rockefeller Foundation, Professor Marks, assisted by Professor Major and Assistant Professor Stanley A. West, is investigating the role of analytic models in the regional planning process. Emphasis is on water and related land use planning, such as the ongoing Southeast New England study being conducted by the New England River Basin Commission. The objectives of this work are: 1) single-resource supply models, such as water supply, water quality management, and power plant siting; 2) land use-water resource impact modeling; 3) resource allocation models; and 4) evaluation indices for quality of life.

Atlantic Generating Station

A group of faculty has been working with the support of the Public Service Electric and Gas Company of New Jersey on a variety of problems associated with the proposed floating nuclear power station. Professor Chiang C. Mei and Assistant Professor Ole S. Madsen are making, respectively, theoretical and experimental studies of the wave forces on floating platforms and of water level oscillations in the protective breakwater enclosure. Professor Harleman and Assistant Professor Keith D. Stolzenbach are making theoretical and experimental studies related to the disposal of waste heat at this plant.

Subterrestrial Exploration and Excavation

Associate Professor Charles H. Dowding has been conducting a feasibility study of a remotely guided, small-bore subterrestrial exploration and excavation device. The project, supported by the U.S. Department of Transportation, includes: 1) the development of long-distance, maneuverable penetrators; and 2) the systematic evaluation of the costs and benefits of alternative devices.

Reaching Power Plant Siting Decisions

The National Science Foundation is supporting Professor Manheim in the development of a methodology for arriving at effective agreement on a siting choice for power plants. Such decisions are usually surrounded by controversy over their environmental and social consequences. It is felt that the ultimate source of difficulty may be the present "decide-announce-defend" approach which is structurally indisposed toward effective representation of these interests and structurally predisposed toward conflict and delay.

The Undergraduate Program

Enrollment in the Department's undergraduate offerings continues to climb, with enrollment increasing in the core subjects, 50 percent in the laboratory subjects, and 38 percent in electives, an average increase of 32 percent. Enrollment in our degree program was 140 at the year's end, a 4 percent increase over 1973-74.
During the year, the Undergraduate Committee, under Professor Moavenzadeh, continued its examination and evaluation of the curriculum instituted in 1970. As a result of this appraisal, the following minor modifications to the core program have been made:

1) Subject 1.11 Introduction to Engineering Systems Analysis has become a School-wide subject incorporating much of the material which our students receive in other core subjects. Accordingly, we have made 1.11 an elective and replaced it in the core with a more advanced subject, 1.15 Systems Analysis for Planning and Design.

2) Subject 1.12 Civil Engineering has had its units reduced by eliminating the case studies, and has been dropped from the required core to elective status as an experiment.

3) Three new case study subjects are being prepared, one by each of the Department's functional Divisions. These are senior year "capping" subjects which will emphasize the relevant issues, methodologies, and solutions, and one will be required in the program of each student.

The proposal for a joint undergraduate degree program with the Department of Urban Studies and Planning has been approved by the faculties of both departments. We hope this will be the forerunner of joint programs with several other departments whose interests border ours.

The Graduate Program

Chaired by Professor Robert D. Logcher, the Department's Graduate Committee has taken the following major actions:

Impact of Departmental Reorganization

The Committee considered the potential competition between the functional divisions and the disciplinary groups in the new matrix structure. It approved the standard division doctorate and engineer degree programs and confirmed that the primary academic role should be with the divisions.

Special Student Enrollment

Special student enrollment continued to grow, increasing almost 25 percent from last year. This growth led to concern over our counseling and admissions procedures for those special students desiring to work ultimately toward an M.I.T. graduate degree. The Committee promulgated and the Department adopted a set of guidelines and procedures which generally limit special student status to those in special (often foreign) programs or to those at M.I.T. on only a part-time basis. For those seeking a degree, continued admission as special students is based on their admisibility as regular students, judged in competition with regular student applicants during the primary admissions period of their first year of enrollment.

General Examination for Doctorate

Extensive discussions were held to determine methods of improving the screening capabilities and pedagogical value of the General Examination. Changes in the content of the exam were
recommended to this end. The intent of these changes is to test the student's ability to solve problems which require an integration of material from individual subjects, to go deeper into material than is possible in a single subject, and to utilize such material in the solution of research problems.

Regular Student Admissions and Enrollment

Both domestic and foreign applications for admission as regular graduate students have increased again this year, the U.S. applicants growing 6 percent and foreign applicants 10 percent over last year. The percentage of U.S. acceptances has declined, however, from 66 percent last year to 52 percent this year. Twenty-six percent of the foreign applicants were admitted.

We enrolled 211 students for the fall term, the largest number in the Department's history. We believe this to be too many for the faculty resources available, however, and plan to reduce the number next year.

Graduate student support has come from the sources shown in the following table:

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<th>Distribution of Graduate Student Support</th>
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<tr>
<td>Fellowship and Trainees</td>
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<td>Research Assistantships</td>
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<td>Teaching Assistantships</td>
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<td>Other (including self support)</td>
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It seems significant that the number of students on research assistantships continues to decline. This is compensated for by an increase in the "Other" category (industrial residents) and in Fellowships and Traineeships (National Science Foundation and military).

Special Training Program

Sponsored by the Food and Agriculture Organization of the United Nations, and under the leadership of Assistant Professors John L. Wilson and Roberto L. Lenton, a training program was developed for four Spanish engineers and an economist in the area of groundwater hydrology. The program was structured around formal subjects, special seminars, work-study trips, a case study, and a state-of-the-art review.
Continuing Education

Associate Professor Wayne M. Pecknold again directed a two-week summer program in transportation systems analysis. This program attracts professionals from government, consulting, industry, and academic sectors and was again oversubscribed.

In June, 1974, Professor Litle offered for the second time a two-week Advanced Study Program on Management in the Construction Industry. The program was attended by 30 top and middle management executives, representing public and private owners, developers, engineering firms, general contractors, and subcontractors. As in 1973, the program was highly successful.

In November, 1974, a professional symposium on Foundation Deformation Prediction was held at M. I. T., under the direction of Professor Thomas W. Lambe. An outgrowth of a research project on the performance of a high embankment placed over a thick clay foundation, the purpose of the symposium was to compare predicted and measured performances of a soft soil foundation subjected to an additional embankment load. The symposium was attended by 75 practicing professional engineers from the United States and several foreign countries.

Trends

Dominant trends are the increasing interest in environmental problems and the resurgence of interest in structural mechanics.

Faculty Changes

Following 27 years of service to M. I. T., Professor Robert J. Hansen will retire this year. Professor Hansen has specialized in structural engineering. Associate Professor Jacques N. Sultan has resigned from the faculty to pursue professional and business interests in Lebanon. Associate Professor Ignacio Rodriguez-Iturbe, Associate Head of the Water Resources Division, is resigning to head a new group in water resources at the Simon Bolivar University, Caracas, Venezuela. Professor Peter S. Eagleson has resigned his administrative appointment as Department Head, effective June 30, 1975, and will spend the coming year on sabbatical leave.

New appointments include Professor Ann F. Friedlaender who comes to M. I. T. from the faculty of Boston College. Professor Friedlaender received the Ph. D. in Economics from M. I. T. and holds a joint appointment with the Department of Economics. She will work in the area of transportation economics. Assistant Professor James M. Becker has joined the faculty following receipt of the doctorate from the University of California at Berkeley. He is working in the area of building design methods and systems. After receiving his Ph. D. from M. I. T. in Operations Research, Gabriel Y. Handler joined us as Visiting Assistant Professor to work on transportation systems analysis. Keith D. Stolzenbach was appointed Assistant Professor of Civil Engineering to work on problems of water quality control. Professor Stolzenbach received the Ph. D. from M. I. T. and comes to us following several years of experience with the Tennessee Valley Authority. Stanley A. West joined the faculty as Assistant Professor and Rockefeller Foundation Post-Doctoral Fellow to work on the social perceptions of environmental quality. Professor West received the Ph. D. degree in anthropology from Syracuse University and comes to us from the faculty of Western Michigan University.
Three of our own recent Ph.D. students have joined the faculty as Assistant Professors; Roberto L. Lenton is working on water resource systems; John L. Wilson is continuing his work on groundwater hydrology; and Daniele Veneziano is applying probability and statistics to problems in structural reliability and water resources.

Honors and Awards

Professor Robert V. Whitman was elected to membership in the National Academy of Engineering. Professor Lambe received the Karl Terzaghi Award of the American Society of Civil Engineers. Professor Hansen and Associate Professor Erik H. Vanmarcke shared the Raymond C. Reese Award of the ASCE for their paper "Human Response to Wind-Induced Motion of Tall Buildings." Professors Logcher and Hansen, along with Professor Jose M. Roesset, received the Moissieff Award of ASCE for their paper "Computer Aided Design of the Standard Oil of Indiana Building." Professor Whitman received the Desmond Fitzgerald Medal of the Boston Society of Civil Engineers Section of ASCE for a paper entitled "Shear Wave Velocity and Modulus of a Marine Clay," Professor Rodriguez-Iturbe has been named a recipient of the Walter L. Huber Research Prize of the ASCE. He shared the Department's annual Conspicuously Effective Teaching Award with Professor Madsen. Assistant Professor John L. Wilson III was appointed a Lilly Teaching Fellow. Professor Vanmarcke was named the second holder of the Gilbert W. Winslow Career Development Chair. Associate Professor Michael S. Baram has been named chairman of the American Bar Association's Committee on Technology Assessments. Professor Charles C. Ladd has been elected Vice President of the Boston Society of Civil Engineers Section of ASCE. Associate Professor Major and Professor Stolzenbach have been named Co-Editor and Associate Editor, respectively, of the journal "Water Resources Research." Professor Moavenzadeh has been appointed chairman of the steering committee of the interdisciplinary program entitled "Adaptation of Industrial and Public Works Technology to the Conditions of the Developing Countries." Sponsorship of the program is by the Agency for International Development. Professor Connor's Fundamentals of Finite Element Techniques for Structural Engineers has been published in a Spanish edition. Numerical Methods in Fluid Dynamics, which he co-edited, also was published this year.

On May 12, 1975, the Arthur T. Ippen Room was dedicated in the Ralph M. Parsons Laboratory. On the same occasion, announcement was made of the establishment of the Arthur T. Ippen Fellowship to be used to assist graduate students in attending national and international conferences to present papers. The Ippen Room, to be used as a combination conference room and library, contains Professor Ippen's private library and mementos of his career.

PETER S. EAGLESON

Department of Electrical Engineering and Computer Science

While the Department's research and graduate teaching in the field of computer science and engineering dates back at least to the 1940s, the number of faculty and students interested in that area remained relatively small until about a decade or so ago. Since that time, student and faculty interest has grown rapidly. The Department's undergraduate curriculum in Computer Science and Engineering was instituted in 1969, and now about 45 percent of our undergraduates and 25 percent of our graduate students are majoring in computer science, while approximately 30 percent of the Department's faculty is committed to teaching and research in the area.
In recognition of this significant change in technical interest, the Department's name was changed on January 1, 1975, from the Department of Electrical Engineering to the Department of Electrical Engineering and Computer Science, the first change in the Department's name since its establishment in 1902. In further recognition of this change, the Institute faculty voted in its April, 1975, meeting to authorize the Department to award the degree of Bachelor of Science in Computer Science and Engineering (as well as the degree of Bachelor of Science in Electrical Engineering), and to change the name of its first graduate degree to Master of Science in Electrical Engineering and Computer Science. These degree name changes will become effective during the 1975-76 academic year.

Undergraduate Education

The total undergraduate enrollment in the Department was just over 700 students this year (about the same as last year). The new undergraduate common-core curriculum is now through its first year and is still being refined and developed. Progress has been very satisfactory, and there is enthusiasm for the program among both students and faculty.

To help with the reorganization of our undergraduate program, the Undergraduate Office was revived this year under the direction of Professor Leonard A. Gould. This office serves as a focus for all of our undergraduate activities, both academic and nonacademic. Through the efforts of this office, Professor Arthur C. Smith was selected as Minority Students Advisor to serve as ombudsman to our minority undergraduates, and a special tutorial program was established and aimed at those of our students with weak high school backgrounds.

The Undergraduate Educational Policy Committee, under Professor Gould, devoted much of its time and effort to discussions of grading policy and the impact of the new M.I.T. grading system on the Department. In addition, the status of our undergraduate teaching laboratories was extensively explored. It is quite clear that the economic problems associated with continuing the laboratories in their current form present very serious difficulties. A small faculty group will study the laboratory problems further over the coming summer.

Graduate Education

The number of regular graduate students enrolled in the Department has been nearly constant, at about 460, for the past few years in spite of an increasing number of yearly applications (rising from 836 in 1973 to 1,015 in 1975). This limitation in enrollments is self-imposed and is due, primarily, to two constraints: first, a limitation on the size of our faculty because of academic budgetary considerations and, second, a limitation on financial support for graduate students because of a marked decrease in available fellowships. While our faculty could probably teach more graduate students in the classroom, their graduate thesis supervision load cannot be increased significantly.

Outstanding teaching by Department graduate students was recognized by awards of $500 each to Carolyn Ross (the Carleton E. Tucker Award), and to Wolf Kohn, Paul S. Schluter, John C. Ufford, and Stephen D. Umans (Supervised Investors Services, Inc. Awards). In addition, graduate students Clement K. C. Leung, Elliot Singer, James R. Yee, and Karim Zahedi were recognized for outstanding Departmental teaching service by promotion to Instructor.
Research

As in the past, most of the research done by members of the Department was performed in various Departmental and Interdepartmental laboratories. With this in mind, only a few research results are noted here. More complete information on research carried out by the Department's faculty may be found in the reports of the following laboratories: the Electronic Systems Laboratory, the Electric Power Systems Engineering Laboratory, the Energy Laboratory, the Research Laboratory of Electronics (R.L.E.), Project MAC, the Artificial Intelligence Laboratory, the Operations Research Center, the Center for Materials Science and Engineering, the Center for Policy Alternatives, the Francis Bitter National Magnet Laboratory, and the Lincoln Laboratory.

Adaptive Control and Failure Detection for Aircraft

Professors Michael Athans, Nils R. Sandell, Alan S. Willsky and Research Associate Keh P. Dunn, together with a team of students, have been investigating adaptive control and failure detection algorithms for advanced aircraft in close collaboration with NASA scientists.

Stochastic Control of Freeway Corridor Systems

Professors Pravin Varaiya and Athans, together with a team of research staff and students, have been investigating the use of advanced modern estimation and control algorithms for the dynamic stochastic control of traffic in a transportation network involving a freeway with a parallel set of signalized arterials.

Reading Machine Computer

The Natural Language Processing Group, supervised by Professor Jonathan Allen, has continued its development of the Reading Machine Computer. A special signal processor has been designed which will soon give the system the capability of real-time speech production. Significant progress has been made in the development of prosodic correlates, making possible the generation of more natural sounding speech. These improvements in text-to-speech conversion promise the production of higher quality speech in such areas as automatic reading to the blind, information retrieval, and computer-aided instruction.

A Very High Level Language for Business Data Processing

Under Professor William A. Martin, a system is being developed which, when given a specification of how the outputs of a business data processing system are mathematically related to the inputs, can automatically design and implement a set of data files and programs to carry out the required processing in an efficient manner. In addition to reducing the cost and time for generating business software, the removal of detail from the system specifications is expected to greatly reduce the difficulty of updating and evolving business data processing software.

Data Communications Networks

A new project was begun during 1974-75 concerning the dynamic behavior of data communication networks. The principal results thusfar are two studies: one by Professor Robert G.
Gallager entitled "Basic Limits on Protocol Information in Data Communication Networks," and the other by Professor Adrian Segall entitled "Dynamic File Assignment in a Computer Network." The work will be expanded in the coming year as an interdisciplinary investigation involving other faculty -- Professors Athans, Sandell, Willsky, and John M. Wozencraft, plus approximately ten graduate students with interests in the fields of control theory, communications, operations research, and computer system architecture.

Network Information Retrieval System

During the past academic year, substantial progress was made toward the establishment of a network of computer-stored bibliographic data bases. Under the leadership of Professor J. Francis Reintjes and Richard Marcus, a graduate student, a rudimentary experimental computer-stored translating interface was brought online. The purpose of the interface is to interconnect several interactive information systems that have different design and operational features so that they appear to a user as one uniform system.

Improved Low Visibility Optical Communication

With increasing congestion at microwave frequencies, optical communication systems will be used for short-haul transmission through the atmosphere; their utility, however, will be determined largely by the outage time they experience in the face of the scattering associated with inclement weather. Professors David J. Epstein, Robert S. Kennedy, Jeffrey H. Shapiro, and Cardinal Warde are involved in a theoretical and experimental project to determine the extent to which the outage time can be reduced by exploiting the contributions of the scattered field at the receiver, a contribution that is usually ignored. Preliminary experimental results confirm than the use of the scattered component can lead to substantial improvements in system performance. Experiments are now in progress to determine the resulting reduction of the outage time.

Digital Signal Processing

Professor Alan V. Oppenheim, together with several graduate students, has been applying a number of new digital signal processing techniques to speech processing and seismic data processing. The speech processing work is directed specifically toward enhancement of degraded speech as experienced, for example, on a faulty communication channel. The seismic data processing has led to the development of a number of significant new techniques which will be potentially useful for exploration seismology.

Audible Noise from Transmission Lines

This project is concerned with the use of electric fields and surface absorption effects to reduce the generation of corona from water drops on high voltage transmission lines. Professors Gerald L. Wilson and James R. Melcher have worked with David W-S Tong, a graduate student, to study this problem. The proposed solution involves treating the individual strands of aluminum conductor to increase their wettability. It is planned to involve conductor manufacturers in the implementation of this scheme to make higher overhead transmission voltage levels compatible with urban areas.
Electrofluidized Beds in Air Pollution Control

With the objective of greatly reducing the residence time required for cleaning particulate from large-scale industrial sources, development continues of an electrically stressed fluidized bed as a filter for pollutant particles. Professor Melcher and members of the Continuum Electromechanics Group have established experimentally corroborated models for filtration performance. Especially in the control of submicron particles such as oil ash, results point to a substantial improvement over existing particulate control equipment.

Nonlinear Wave Interactions in Plasmas

Significant progress was made in the theoretical description and understanding of nonlinear wave interactions in plasmas. This work is part of a continuing project of Professor Abraham Bers and his students within the R.L.E. plasma research program. The results are important to current studies of heating plasmas to temperatures that would initiate thermonuclear fusion of light nuclei.

Polymeric Fire Detector

An early warning fire-detection device is being developed by Professor Stephen D. Senturia. The device exploits the change of the electrical resistance of polymer films following exposure to combustion gases. Developed in collaboration with Professors Clifton G. Fonstad and Clark K. Colton, the prototype devices have been tested for responses to a wide spectrum of gases and to smouldering cellulosic fires, and have been found to be reversible and suitable for use in normal office and home ambience.

Amorphous/Crystalline Semiconductor Devices

Professor David Adler and Kurt E. Petersen, a Research Assistant in the Department, have fabricated a three-terminal hybrid amorphous/crystalline semiconductor device that has several unique properties. At low and moderate collector voltages, all terminal-to-terminal impedances are high and the current gain is of the order of 0.1. Application of a small base pulse switches the amorphous emitter to a conducting state, yielding normal transistor action and small-signal gains of the order of 10. After the cessation of the switching pulse, the device stays in the high-gain state, producing a memory effect which remains until the original collector voltage is removed. The device could be used as a threshold amplifier or as the basis for ternary logic, among other potential applications.

Light Scattering in Magnetic Semiconductors

Research Associate Dr. Vincent Tekippe and a group of graduate students under the direction of Professor Mildred S. Dresselhaus have been engaged in a study of light scattering from magnetic semiconductors at the Francis Bitter National Magnet Laboratory in collaboration with Dr. Roshan Aggarwal. Magnetic semiconductors form a class of materials which are of interest because their electrical transport properties can be changed by orders of magnitude through the application of an external magnetic field. The magnetic semiconductors under investigation are the europium chalcogenides which crystallize in the rock salt structure, for which first-order Raman scattering is symmetry-forbidden. For this reason, the observation of a first-order Raman scattering signal is associated with magnetic processes. Of significance is the observation of a variety of Raman spectra, each characteristic of a specific
magnetic phase of the system, including paramagnetic, ferromagnetic, ferrimagnetic, and two different anti-ferromagnetic phases.

Ultra Fast Optical Pulses

The optical properties of narrow-energy-gap semiconductors are of particular interest because of the extremely short lifetimes of electron-hole pairs. These lifetimes, in the $10^{-12}$ second range, have led to the development, under the supervision of Professor George W. Pratt, Jr., of an ultrafast optical shutter in which a pump beam bleaches the optical absorption of a probe beam. Picosecond infrared pulses produced in this manner would be significant in optical communications and in the probing of chemical reactions.

Quantitative Analysis of Erythrocyte Sickling

Professor Ian T. Young has developed a procedure for using a computer-controlled automated microscope to determine the severity and extent of sickling in human red blood cells, erythrocytes. Working in collaboration with Professor Vernon Ingram of the Department of Biology and Ms. Jeffrey Hagerich of the Research Laboratory of Electronics, Professor Young has used image processing techniques on the cell shape to assess the degree of sickling in individual erythrocytes and the percentage of erythrocytes in a blood sample that exhibit the sickling phenomenon. This technique should provide a rapid, objective mechanism for aiding in the diagnosis and following the response to therapy of sickle cell anemia.

Faculty

Promotions in the Department faculty this year include Provost Walter A. Rosenblith to Institute Professor, Associate Professors Allen, David Adler, Albert R. Meyer, and Fred C. Schewepe to Professor, and Assistant Professors Timothy L. Johnson, Barbara H. Liskov, and Suhas S. Patil to Associate Professor. Also, Assistant Professor Alan J. Grodzinsky was named the Esther and Harold E. Edgerton Assistant Professor of Electrical Engineering, while Assistant Professors Madhu S. Gupta and Gerald J. Sussman were appointed Lilly Postdoctoral Fellows in the Division for Study and Research in Education for the 1974-75 academic year.

New laboratory director appointments include Professor Michael L. Dertouzos to Director of Project MAC, and Associate Professor Joel Moses to Associate Director of Project MAC; Associate Professor Patrick H. Winston to Director of the Artificial Intelligence Laboratory, and Assistant Professor Willsky to Assistant Director of the Electronic Systems Laboratory.

Honors and Awards

Among Department and faculty receiving honors this year were Professor Peter Elias, who was elected a member of the National Academy of Science; Professors Wilbur B. Davenport, Jr., Gerald P. Dinneen, and David C. White, who were elected members of the National Academy of Engineering; Professor Emeritus John G. Trump, who was elected an Honorary Fellow of the American College of Radiology; and Professor Fernando J. Corbato, who was elected a Fellow of the American Academy of Arts and Sciences. Professor Corbato was also elected a Fellow of the Institute of Electrical and Electronics Engineers, as were Professors Kennedy and Reintjes.
Other faculty awards and honors include the following: Professor Dertouzos, who received the 1975 Frederick Emmons Terman Award of the American Society of Engineering Education, for his contributions as an "outstanding young electrical engineering educator"; Professor Dresselhaus, who was elected a Director of the Associated Harvard Alumni; Professor Henry J. Zimmermann, who received the 1975 Alumni Achievement Award of the Washington University School of Engineering and Applied Science; Associate Professor Senturia, who received the 1974 Industrial Research IR-100 Award for an Automated Solid Waste Reclamation System (together with Professor David G. Wilson of the Department of Mechanical Engineering); Assistant Professor Johnson, who received the 1974 Donald P. Eckman Award of the American Automatic Control Council as an "outstanding young contributor to the field of Automatic Control"; and Assistant Professor Willsky, who received an M.I.T. Graduate Student Council Teaching Award.

WILBUR B. DAVENPORT, JR.

Department of Materials Science and Engineering

Undergraduate Programs

This past year was the second year in which the new undergraduate program was offered in its entirety. The enrollment of 45 students in the program was about the same as in the preceding year. The incremental increase in the number of registered undergraduates which did not materialize this year appears to be on the way next year. We anticipate from pre-registration information that in the next academic year the number of undergraduates taking a full program in materials science and engineering will increase by approximately 20 to 25 students. Some changes in the program have been made as a result of our experiences during the first year. These have been mostly in the laboratory courses, which are now consolidated and to which we expect to add a number of experiments in polymers.

During the year, a proposal that we establish a cooperative program was studied in detail by the faculty, discussed usefully with the Visiting Committee, and finally approved by the Committee on Educational Policy. The program is modeled on one which has been in operation for some time in the Department of Electrical Engineering. By proper arrangement of the work period and on-campus courses, it is possible for a student to obtain a Bachelor's degree in four years or a Bachelor's and Master's degree simultaneously after five years. The first three students in the cooperative program have enrolled, and we have three industrial concerns working with us to develop the program. We anticipate that it will grow rapidly in the next year or two.

Our major service subject offerings have continued to prosper. Introduction to Solid State Chemistry 3.091 was taught this year for the first time without the participation of Professor Emeritus John Wulff, who founded the subject some years ago. As in previous years, more than 450 students registered for the subject. One of the follow-on subjects, 3.141, which is designed primarily for mechanical engineers, was taught by Professor Regis M.N. Pelloux, and once again had considerable success. Most of the 45 students registered for the subject were from the Department of Aeronautics and Astronautics. Professor Harry C. Gatos organized 3.092, a subject which is designed to expose the range and depth of materials science and to give some idea of the research interests of the faculty in the Department. More than 30 sophomores and juniors took the subject.
Graduate Programs

In 1973-74 we spent a great deal of time reorganizing the numerous graduate programs in materials science, metallurgy, ceramics, materials engineering, and polymerics, and other areas into five interrelated but separately coherent programs. We put the different pieces of metallurgy back together again, left the ceramics program virtually unchanged, and designed a polymerics program which is comprehensive in its coverage and which also provides an opportunity for the physical aspects of the science and engineering of polymers to be studied in depth. The two remaining programs deal with aspects of all three classes of materials. They are materials science, which is concerned with the basic applied science necessary to understand phenomena common to all materials, and materials engineering, which is a new concept developed at M.I.T. over the last few years. This program combines a concern for the more sophisticated aspects of modern materials-processing technology with materials systems analysis, involving the economic, societal, and technological components of the total problem and with problems of technology transfer in the materials processing area. In 1974-75 all five programs were presented for the first time, and the general examinations were organized appropriately. The tentative conclusion after only one year is that these programs are successful. The total number of graduate students rose for the first time in six years, increasing to more than 130 students. The new polymerics program, which relies heavily upon subjects taught by faculty in other departments, attracted 16 graduate students. The other four programs each attracted about 30 students. The graduate committee has met throughout the year with representatives of the graduate students to discuss the programs as they developed. There have been, of course, some minor problems and difficulties but these have all been resolved to everyone's satisfaction. The general response from the students has been enthusiastic.

The research volume increased last year more than had been anticipated. We estimated a volume of $2.4 million for fiscal 1975, and the actual expenditures will probably be in excess of $2.7 million. The largest amount of increase came through the ceramics group who are doing much research relating to materials for energy developments. Most of this group are associated with the Energy Laboratory, and much of the funding has been channeled through that organization. The Center for Materials Science and Engineering has also received a substantial increase in funding which has benefited the Department. It is anticipated that the research volume will increase even more sharply in the coming year. Grants and contracts already confirmed are more than 30 percent in excess of last year's expenditures. Cooperative research activities throughout the Department are developing to enable the faculty and students to play a full part in the work relating to such national problems as coal gasification technology, solar energy, and nuclear power generation.

The expanding research activity has not been confined to science and hardware technology. During the year a substantial effort went into laying the groundwork for an expansion of work in the systems analysis of materials processing and other materials problems. Professor Merton C. Flemings, in collaboration with the Center for Materials Science and Engineering, organized a successful conference on the recycling of aluminum. The Department, in collaboration with the Center for Policy Alternatives, presented a colloquium series on materials policy which attracted many distinguished scholars and interested students. This is an area in which we expect to grow rapidly in the next few years.

Faculty

Professor Emeritus Antoine Gaudin died on August 23, 1974. He was a most distinguished minerals engineer, who spent virtually all of his professional career in this Department.
Many of his former students hold important positions in the minerals industry, and his contributions to research and the development of technology in this area are internationally recognized.

Professor H. H. Uhlig gave his well-known graduate subject on corrosion for the last time during last year. He will relinquish his Senior Lecturer appointment at the end of the year to take up a position at Woods Hole Oceanographic Institution, where he will continue his research on corrosion.

To the edification of his colleagues, Professor Morris Cohen was promoted to Institute Professor. During the year the promotions of K. H. Johnson and D. R. Uhlmann from Associate Professor to full Professor and of J. B. Vander Sande from Assistant to Associate Professor were approved. Dr. David Roylance from the polymer laboratory at the Army Materials and Mechanics Research Center in Watertown joined the faculty as an Associate Professor.

In April it was announced that Professors John F. Elliott and W. D. Kingery were elected to the National Academy of Engineering. Also in the spring, Professor Cohen gave the Killian Lectures at M.I.T. Professor Bernhardt J. Wuensch received the Graduate Student Council Department Teaching Award.

Last year Professor Gatos received the Electrochemical Society's Award in Solid-State Science and Technology. Professor Flemings gave the Axel Hultgren Memorial Lecture of the Swedish Association of Physical Metallurgists. Professor Thomas B. King was elected a Fellow of the Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers, and Professor Walter S. Owen was elected a Fellow of the American Society for Metals.

Research

The research program in ceramics has proceeded along a broad front which, in the past year, has included studies of crystal structure and microstructure; thermodynamics of lattice defects, solute interactions and influence by grain boundaries; and mobility studies of lattice defects, ions, and grain boundaries. These phenomena are directly related to technological problems such as microstructure evolution during processing, creep, electrical conduction, and pore and ion migration under the influence of thermal gradients. Many of these areas are of prime concern in energy-related materials problems.

Professor Harvey K. Bowen and his co-workers have studied the effect of thermal gradients on oxygen redistribution in urania, a phenomenon which affects the efficiency of nuclear fuel. A theoretical model was formulated, and the importance of oxygen flux versus local equilibrium with the gas phase was established for various conditions of thermal gradient and sample configuration. In connection with a program concerned with laser windows, Professor Bowen has investigated the growth of CdTe by vapor deposition and the mobility of grain boundaries in forged alkali halides. Besides developing processing conditions to produce stable, fine-grained structures, the latter study has produced data for boundary mobility which provide excellent corroboration of impurity-drag theory. In additional energy-related ceramics research, Professor Bowen has studied electrode protection magnetohydrodynamics (MHD) systems through control of gas phase and slag composition, and has discovered new electrode compositions which are compatible with slag. In collaboration with Professor Robert L. Coble, he has assembled an all-ceramic fuel cell which employs a high conductivity ceramic as an electrode and a conventional calcia-stabilized zirconia electrolyte. The cell was tested under both oxidizing and reducing conditions, and demonstrated the potential for a high-temperature fuel cell of simpler design than the devices which have been described in the literature.
Professor Coble and his students have continued to study kinetics and microstructure evolution during processing and service of ceramics, and have determined defect mobilities in ceramics. A study of coarsening and morphological change in a microstructure with two isotropic interconnected phases has been completed and has clarified conditions under which the morphology remains stable rather than spherodizing. Professor Coble also has conducted extensive theoretical analysis of situations in which a quasi-steady state analysis may be applicable to diffusion-controlled processes. Shown to be amenable to such treatment are the kinetics of several significant processes: initial stage sintering, oxidation, and pore closure during final stage sintering. Most kinetic studies provide information on the most rapidly diffusing defect. Professor Coble has found that isolated pore growth and equilibration of crystal density are two processes which may be exploited to obtain information on transport of the slower species, and he is conducting experiments in these areas.

Professor Kingery has initiated a broad program to permit understanding of grain boundary and impurity precipitation phenomena in magnesium oxide (MgO), a typical ceramic oxide for which much confusing impurity-influenced data exists. A number of parallel studies are therefore being directed towards a single well-characterized material. Calculation of impurity ion-vacancy association equilibrium has shown that associated defects should be present in MgO in larger concentrations than isolated vacancies. Measurement of the distribution of aluminum impurity in MgO has revealed a nonequilibrium segregation to surfaces, the extent of which depends upon thermal history. Space charge near a boundary is being evaluated theoretically, and dielectric loss measurements to study the space charge around dislocations have commenced. In situ observations of the high temperature motion of extended defects and of precipitation have begun with a specially modified transmission electron microscope. Continuing his work with archaeological ceramics, Professor Kingery has shown that the discovery of firing in neolithic times began with production of burnt lime plaster rather than in connection with earthenware bodies as previously supposed.

Professor Wuensch has continued studies of ion migration in solids, especially the measurement of self-diffusion rates in high purity ceramics at very high temperatures. He has examined the possibility that a transmutation product of different valance may significantly alter the electrochemical equilibrium state of an ionic solid in diffusion experiments which employ a radioactive tracer isotope. A theory has been formulated which predicts that apparent diffusion coefficients may be in error by an order of magnitude for certain combinations of tracer activity and half life. In connection with a study of solid state electrolytes, Professor Wuensch has succeeded in producing nucleation and growth of single crystals of \( \alpha \)-AgI at high temperatures, and has conducted the first single-crystal diffraction analysis of the distribution of the mobile ions in this fast ion conductor. Continuing studies of heavy metal chalcogenides have resulted in determining the crystal structures of two members of the homologous series \( \text{Pb}_{3+2n} \text{Sb}_{8+15} \). On the basis of these results, Professor Wuensch and his students have been able to predict in detail the structures and compositions of additional hypothetical phases. Such predictions are an ultimate goal of crystal chemistry, but one which is seldom realized in practice.

In the area of metallurgy, work on steels has expanded rapidly. Basic kinetic processes, by which the structure of high strength, low alloy microalloyed steels is developed, are being studied by Professor Cohen in steels with very small additions of niobium. In the near future, work on this important class of new structural steels will be extended to include steels microalloyed with vanadium. The theoretical model for nucleation in martensitic transformations in steels which Professor Cohen and his students have developed over the last two years has now been extended to the more complicated case of stress-assisted and strain-induced nucleation. This theory provides a scientific basis for the design of transformation induced plasticity (TRIP) and other types of very strong steels. Professors Cohen and Owen have extended their interest in martensites and premartensitic effects in ordered alloys such as NiTi, Fe3Pt, and CnAlNi. The acoustical damping and the change in strength and stiffness which accompany
these changes are being studied with the object of developing the principles on which high-
damping and high-strength alloys can be developed. Professors Roy Kaplow and Cohen have
continued their investigations of the atomic rearrangements which occur in the early stages
of tempering hardened steels. Stress relaxation during tempering can now be explained; it
results from plastic zones induced by the local volume changes due to precipitating carbides.
As a result, the kinetics of stress relaxation are controlled by the structural changes which
occur during tempering, and not by slip. There is now evidence that prior to such precipi-
tation the carbon atoms segregate into regions of high and low concentration (clustering).
An ordered configuration, probably corresponding to Fe$_4$C, emerges in the high-order
regions.

Under the terms of a protocol involving the Soviet Union and the United States, Professors
Elliott, Flemings, and King are conducting research on electroslag and plasma-arc remelting.
Professor Elliott is working on the re-solution and precipitation of nonmetallic inclusions, and
Professor Flemings is doing experimental and theoretical studies of heat flow and solidification,
both with respect to the electroslag process. Professor King is studying electrochemical re-
actions involving impurities in the electroslag process and the kinetics of nitrogen solution in
the plasma-arc process. The Soviet research, principally at the E. O. Paton Institute in
Kiev, is complementary and mainly concerned with heat flow studies on pilot-scale melting
equipment.

Professor K. C. Russell has been developing a theory for the coarsening of compound pre-
cipitates in a metallic matrix. The theory has been generally verified experimentally and
should help in the development of superior, oxide-dispersion-strengthened, high temperature
alloys. These are of interest as possible materials for the first wall of future controlled
thermonuclear reactors.

Professor Michael B. Bever continued the analysis and interpretation of experimental results
for the deformation behavior of bismuth and the long-range ordered alloy Mg$_3$Cd. The mechan-
ical properties of Zircaloy tubing were investigated as a function of processing history and
crystallographic texture in an investigation conducted by Visiting Scientist Dr. M. Hamasaki
under the joint supervision of Professors Pelloux and Bever.

Polymer research during the past year has concentrated on the molecular aspects of fracture,
on studies of local order in glassy polymers, and on the application of modified linear elastic
fracture mechanics to fiber reinforced polymeric composites. In all three areas, substantial
progress has been achieved.

The question of local order in nominally glassy polymers has received wide attention recently.
Electron microscope observations of structures on a scale of 30-200 Å occupying a large volume
fraction in nearly all glassy polymers have cast serious doubt on the standard structural models
for amorphous polymers and on the understanding of their mechanical properties based upon
these models. Recent work by Professor Uhlmann and his colleagues on a number of glassy
polymers -- including polycarbonate, polymethyl methacrylate, polyethylene terephthalate,
and polystyrene -- has indicated that heterogeneities seen by electron microscopy are not
representative of the bulk materials. For every polymer investigated, the small angle x-ray
scattering (SAXS) indicates a level of density fluctuations in the materials which corresponds
closely with that expected from thermodynamic fluctuation theory for fluids applied at the
glass transition. High resolution electron microscope studies of polycarbonate are in
consonance with the SAXS results in indicating the absence of structure on the scale of the
reported nodular features.

In addition to the density fluctuations, the small angle x-ray scattering indicates a small con-
centration (in the range of 0.01 to 0.1 volume percent) of large heterogeneities (in the range
of hundreds to thousands of Ångstroms). These heterogeneities are present in much smaller
concentrations and are much larger in size than the nodular features reported in the electron microscope studies. They are distributed through the bulk of the polymers and have been associated with material which is extrinsic to the polymer such as dirt or process aids. In the case of polyethylene terephthalate, the presence of a small concentration of crystallites was also indicated. It is concluded, therefore, that the nodular structures previously reported in all of these glassy polymers should be associated with surface effects and not with the bulk material.

Professor Roylance has studied the physics of fracture in polyethylene by neutron magneto resonance (NMR) and other similar techniques to detect free radical formation during gross tensile fracture. The results indicate that a substantial amount of molecular chain scission occurs and that the general theory of bond rupture postulated by Zhurkov is valid. Future plans include the use of gel permeation chromatography to determine the distribution of intercrystalline tie-chain scission occurring in oriented polymers subjected to stresses up to and including fracture, and at various temperatures and loading rates. The gel permeation chromatography (GPC) observations will be correlated with a thorough characterization of the materials structure, especially the amorphous fraction and the degree of orientation, and with auxiliary measures of molecular fracture (electron paramagnetic resonances, infrared spectroscopy, and small angle x-ray diffraction). Information obtained from these experiments will be used to develop an analytical rate-process model of fracture which depicts realistically the distribution of spatial defect sites as well as the distribution of tie-chain contour lengths.

Professor Frederick J. McGarry, and Research Associates Dr. John F. Mandell and Dr. Su-Su Wang, working from linear elastic fracture mechanics, have developed a finite element analysis of the stress field surrounding a notch or crack tip in multi-ply fiber reinforced plastic matrix composite materials. This is a generalized, three dimensional computer program which identifies the stress in any direction in any layer or between the layers of such structural composites. It also is capable of determining the relaxation of the crack tip stress singularity caused by interfiber splitting within one ply or by interply delamination, both of which processes principally contribute to overall crack growth and macroscopic failure. Experimental work has elucidated the micromechanics of the fracture process and has guided the damage modeling component of the analytical development. In addition, it has identified the energy absorbing sources of fracture toughness in these materials and led to an understanding of crack growth under static and cyclic fatigue stressing. A theory for these phenomena has been developed. The effects of water on crack growth also have been studied, since marine applications of structural composites are numerous and important.

Research in materials science has proceeded on a broad, interdisciplinary front. The following highlights are intended as a sampling of the range of research activities.

The electronic materials group of the Department, under the direction of Professors August F. Witt and Gatos, participated in the Skylab Program and had six semiconductor crystal growth experiments performed in space during the Skylab III and Skylab IV missions. On the basis of these experiments, it was established that ideal diffusion controlled steady state conditions, never accomplished on earth, were achieved during the growth of Te-doped InSb crystals in Skylab. It was possible, for the first time, to identify unambiguously the origin of segregation discontinuities associated with facet growth, the mode of nucleation and propagation of rotational twin boundaries, and the specific effect of mechanical shock perturbations on segregation. Ground-based tests for semiconductor crystal growth experiments performed during the Apollo-Soyuz mission were completed.

The breeder reactor and controlled thermonuclear reactor present intriguing problems because the irradiation environments characteristic of these devices bring about changes in materials structure and properties that are time dependent. Simulation of the neutron environment, either mathematically or via other particle irradiations, is therefore necessary. Professors
A. L. Bement and Russell have investigated the phenomena of void swelling, phase instability, and creep in an irradiation environment. A mathematical model for void nucleation has been developed and evaluated numerically. Its predictions are in accord with experimental results and will be used in projecting the effects of irradiation type and intensity, transmuted gases, and temperature on in-reactor swelling behavior.

Alkali halide and II-VI compound semiconductor type materials transmit infrared radiation and are being considered as materials from which laser windows might be made. In addition to a low optical absorption coefficient, laser windows require substantial mechanical strength. Professor Bowen's studies on these materials include grain boundary strengthening, fracture statistics, and the relationship between IR absorption and the processing parameters. Transmission electron microscopy has been used with laser calorimetry to reveal microprecipitates. Band edge shifts and the electrical properties have established the source of absorption in CdTe. Techniques for measuring low absorption coefficients on small samples have been developed.

Professor Robert M. Rose of the Department, and Professor Margaret MacVicar and Dr. Judith Bostock of the Department of Physics, have continued their research in structure-property-processing relationships in superconducting materials. These materials are used in devices which open up numerous possibilities: controlling thermonuclear reactions; generating, transmitting, and utilizing electric power with great efficiency, reliability, and convenience; detecting miniscule magnetic and gravitational fields; levitating high speed vehicles; creating a new generation of particle accelerators; and many other equally exciting prospects. All such applications require the fabrication of superconducting materials with superior technical properties, e.g., the ability to carry huge supercurrents in equally high magnetic fields. These properties are quite sensitive to the microstructure, which in turn depends crucially on the processing of the material.

The selfconsistent field Xc method, developed by Professor Johnson of this Department and Professor J. C. Slater of the University of Florida, has been applied by Professor Johnson to electron energy calculations in several commercially important catalysts. Electronic structure calculations have been completed for clusters of Cu, Ni, Pd, and Pt containing up to 13 atoms. These are prototypes of the very small clusters (less than 10 Å in size) which constitute the active centers of commercial heterogeneous catalysts.

Research in materials engineering has been very active during the past year. Continuing work by Professor Nicholas J. Grant and his students on the superplastic behavior of AlCu alloys has shown that creep tests run to large strains do not exhibit a maximum in the strain rate exponent as previously reported. It was also found that there is no threshold stress for superplastic flow and that ductility continuously increases with decreasing strain rates. The mechanisms of deformation appear to be primarily controlled by grain boundary sliding and recovery processes but not diffusional creep.

Amorphous CuZr alloys produced by rapid quenching from the melt (splat cooled) have been examined for structural stability, and the rates of transformation to the crystalline state have been measured. Unusually high values of tensile strength are obtained for this amorphous alloy. In similar studies, rapid quenching of a casting superalloy, IN 100, followed by compaction by extrusion of the cast splat particles, led to a fine grain size alloy which demonstrates a superplastic behavior at elevated temperatures with total elongation to rupture as high as 1200 percent.

The corrosion fatigue behavior of high strength stainless steels, such as martensitic and duplex austenitic-ferritic steels, has been investigated by Professor Pelloux over a range of cyclic stresses in different environments. It was found that corrosion fatigue crack initiation in martensitic alloys was caused by preferential dissolution of ferrite between martensite laths, thus creating a local notch. In the austenitic-ferritic alloys, initiation results from the enhancement of the slip process in the austenite phase caused by the dissolution of the surface slip step.
The high temperature fatigue crack growth resistance of different structural superalloys is being evaluated from $1000^\circ$ to $1500^\circ$ F. The critical parameters which control the fatigue strength are the oxidation resistance and the stability of the microstructure under the combined creep-fatigue plastic deformation. It was found that the transition from intergranular to transgranular fracture at low cyclic frequencies results in accelerated crack growth rates and a marked loss in fatigue strength.

Professor Russell and his students have studied the coarsening rates and the stability of oxide phases used to strengthen high temperature alloys. Experimental results for a CuSiO$_2$ alloy generally verified the theory, including the prediction that useful dispersoid lifetimes can be increased by orders of magnitude through judicious control of the processing variables.

Professors Robert Mehrabian and Flemings have made considerable progress in their work on a novel method of casting ferrous alloys in permanent molds. This project, supported by the Advanced Research Projects Agency of the U.S. Department of Defense, involved cooperative research between M.I.T. and a number of industrial companies. The most promising method is "rheocasting," wherein the molten alloy is partly solidified while being vigorously stirred, then injected into a mold by electromagnetic techniques. Much longer mold life is predicted because of the lower temperatures and reduced latent heat of solidification. A pilot scale apparatus is presently under construction.

Professor Walter A. Backofen's work last year was concerned with the nature of the strain-state dependence of the strain hardening characteristics of ductile metals; an issue of much fundamental interest, not yet recognized in strain hardening theory, and of much practical interest as well for its effect on the design rules now being developed for engineering analysis of sheet-metal stampings. Professor Backofen also continued his study of the nature of granite, especially as this relates to the action of microstructure, microcracking, and dilational deformation on the toughness of the material. Another project involves the study of the plastic anisotrophy of alkali-halide crystals, with emphasis on how the different shear-system strengths influence the general plasticity and texture hardening potential of polycrystalline material.

Professor Bever has devoted much effort to studies of the economics of materials. These are concerned with an assessment of deep-sea mining, the substitution of materials, dissipative uses of lead, and an appraisal of the status and prospects of metal-matrix composites. An investigation of the conservation of materials continues, with special emphasis on the interactions between technical and economic factors in recycling. Work concerned with the dynamic supply-demand balance of copper and aluminum was started.

WALTER S. OWEN

Department of Mechanical Engineering

This has been a year of transition to new leadership in the Department, of substantial growth in both the student body and the level of sponsored research, and of self-examination and planning. Mechanical Engineering has always been a profession broadly concerned with energy and materials, and the design, production, and management of systems to meet human needs. Its evolution over more than a century saw an early emphasis, even prior to 1900, on strength and properties of materials, heat, power, fluid flow, and machine design. Analytical methods and the development of engineering sciences such as materials, applied mechanics, fluid mechanics, thermodynamics, and heat transfer emerged during the first half of this century.
In many cases, the Department led both in the evolution and the pedagogy of these disciplines. The 1940s and 1950s brought problems of national defense and aerospace into the forefront, and saw vast expansion of engineering research and a preoccupation -- particularly in educational institutions -- with problems where the best technical solution was optimum, and where cost and social considerations were secondary. During those years, the majority of the Department's graduates entered the defense and aerospace industries or became faculty members at other schools of mechanical engineering.

The last decade has seen a broadening of the profession and of mechanical engineering education, in which the Department has pioneered. Computers have begun to play a powerful role in the design, optimization, and management of mechanical engineering systems. New fields have emerged: control and optimization, human factors, biomedical engineering. Societal problems such as safety, productivity, health care, transportation, environmental protection, and energy supply and conservation have moved to the forefront, and our faculty increasingly work together with faculty from other disciplines and professions, such as law, medicine, and economics.

There has been increasing concern with the broader implications of systems analysis and management. These continuing changes and their implications for the future of the Department and the profession led to a major undergraduate curriculum revision which was implemented in 1974-75, and motivated an extensive planning activity conducted by an ad hoc faculty Planning Committee appointed in fall, 1974. The purpose of this Committee was to evaluate the Department's strengths, weaknesses, and potential, and to make recommendations for goals, policies, and directions for the Department in professional areas of emphasis, educational programs, Departmental organization, staff development, and physical facilities and space. The Committee's recommendations are currently under review, and will be presented to the faculty as a whole in fall, 1975.

The Planning Committee has developed a comprehensive space plan which would consolidate most of the now scattered activities of the Department in three principal locations: the traditional location in Buildings 1 and 3; the Sloan Building, 31; and the Metals Processing Laboratory, 35. The plan also calls for the development of a Biomechanics and Human Rehabilitation Laboratory centered on the first floor of Building 3, and a Center for Engineering Design located along the fourth floor main corridor and under the roof dome of Building 3. It is hoped that development funds can be obtained to implement these rather ambitious plans.

The Committee also will recommend a comprehensive study, and subsequent revision, of the graduate educational program. A further recommendation will be that the Department find ways to establish closer ties with industry in research and teaching, and that the Department also consider expanding its cooperative program to include graduate as well as undergraduate programs, possibly with some thesis work performed off campus.

The organization of the Department along three divisional lines -- Mechanics and Materials, Fluid and Thermal Sciences, and Systems and Design -- was continued in the same format as in the past. The Steering Committee set Departmental policy and provided advice to the Department Head on appointments and promotions, and guided the equitable distribution of responsibilities among the various groups in the Department. Special acknowledgement is made to the three division heads, Professors Ernest Rabinowicz, Joseph L. Smith, Jr., and David Gordon Wilson, and to the three other members of the Steering Committee, Professors Ali S. Argon, Peter Griffith, and Henry M. Paynter, for their dedicated efforts during the past year.

Regular open meetings of the Department faculty were instituted and served to support the divisional structure and to provide a forum for discussion and guidance on various issues considered vital to the continued well-being of the Department. There was a great deal of apprehension expressed by the faculty about the increasingly heavy loads in teaching,
research, and administration which they are being called upon to carry in the continuing climate of increasing enrollments and budget reductions.

This year, the Department participated with the School of Engineering in the new task-oriented budget process. A programmatic structure was developed in the categories of teaching, research, administration, and Institute/public service. All activities of the Department were specifically defined and categorized within the programmatic structure, and the level of effort required to accomplish these tasks was identified and translated into budget requirements. Where possible, quantitative measures of performance, such as student credit hours taught per dollar, were identified. Although this process increased the administrative load in the Department, it proved useful as a program planning tool; it identified the costs and benefits of various activities and set priorities among competing activities.

In recent years, the size of the faculty has decreased because of budget stringencies, while the Department's work load has continued to increase. The Department faces a reduced budget for the coming academic year and possibly a much larger reduction in the following year. These factors result in an increasingly overloaded faculty, reductions in opportunities for professional growth, an increasing tenure ratio, and insufficient numbers of young faculty. It is remarkable that despite these problems the Department remains vigorous and dedicated and continues to foster programs unmatched in quality and reputation.

Consolidation of the academic offices was completed this year with a move of the Graduate Office to space adjacent to the Undergraduate Office, the Administrative Office, and Department Headquarters. This has led to improved efficiency, better coordination, and the consolidation into one area of services to the students. Pending modifications of this space will further improve these operations.

The Joint Civil Engineering/Mechanical Engineering Computer Facility continued to provide students from both these departments, as well as students from the Department of Ocean Engineering, with experience in digital, analog, hybrid, and interactive computing, including online graphics. The increasing use of this facility is exemplified by the enrollment in 2.10-2.11 Elementary Programming and Machine Computation taught by Professor Roger E. Kaufman. The combined number of students enrolled in the spring and fall terms increased from 242 in 1973-74 to 352 in 1974-75.

The past year has seen further growth in Departmental cooperation with interdepartmental resources -- the Center for Transportation Studies, the Harvard-M.I.T. Program in Health Sciences and Technology, the Rehabilitation Engineering Center, and, especially, with the Energy Laboratory.

In line with the Department's objective of closer ties with industry, the M.I.T.-Industry Polymer Processing Program, under the direction of Professor Nam P. Suh, is exemplary. By combining support from the National Science Foundation (NSF) with support from various industrial concerns, the program is innovating new techniques for polymer processing based on fundamental understanding and synthesis of the basic disciplines of engineering and materials science. This marks an important step toward increasing cooperation with industry, and demonstrates that many of the associated problems -- patents, proprietary information handling, publications, etc. -- can be resolved to the benefit of all parties.

Further cooperation with industry was discussed this year by the Visiting Committee under the Chairmanship of Irénée du Pont, Jr. in a meeting on May 1, 1975. Discussions were about emerging areas in mechanical engineering, the needs of industry with regard to academic programs, possible faculty/industry exchanges, cooperative programs, and the potential for joint ventures with industry.
The design, implementation, and management of large scale systems involving technology and social issues in such areas as transportation, health care, production, and environmental protection require that the traditional engineering disciplines be integrated with those of economics, systems analysis, law, and political and behavioral sciences. During the past academic year, Professor Thomas B. Sheridan led an interdepartmental planning committee which resulted in an interdisciplinary Master's degree program in Technology and Policy which will be offered by the School of Engineering beginning in fall, 1975. This program represents a major step toward educating engineers for work in government or industry doing impact studies, technology assessment, or planning policies and designing hardware for large scale technical systems.

Undergraduate Program

Enrollment

With the enrollment of 63 sophomores in October, 1974, the total undergraduate population rose to 212 students, of whom 88 were juniors and 61 seniors, an increase over last year of 12 percent. Comparison with the registration of 128 in October, 1971, suggests that students have begun to recognize that mechanical engineering can fulfill their present career aspirations while giving them enough flexibility to move easily into other careers if they so desire. The enrollment of women and minorities has continued to grow and each now comprises roughly 10 percent of the total undergraduate population. Despite an economic recession, the profession is offering increasingly attractive employment opportunities, particularly to women and minorities.

Whether this trend toward increasing enrollment will continue very far into the future is unclear in light of the forthcoming reduction in numbers of students reaching college age. To even keep our enrollments constant will require that we attract an increasing percentage of the students entering college. This is unlikely unless there is a substantial increase in engineering salaries, which have been decreasing in real dollars over recent years.

The enrollment in Course II-A, the undesignated degree program, remained stable at a level of 25 students. The number of students enrolled in the Cooperative Program, II-B, has increased over the past few years, indicating rising student interest in industrial practice. Unfortunately, this interest comes at a time of economic recession when there are insufficient numbers of jobs available. A more formal commitment between industry and the Department is needed for the future success of this important program.

Undergraduate Executive Committee

The primary focus was on guiding the Department through the first year of the revised curriculum. Much emphasis was placed on the quality of teaching and coordination of teaching assignments in relation to faculty interests and professional development. Objective and corrective evaluations of teaching were possible because of better feedback. The procedures for subject and instructor evaluations conducted by the student honorary society, Pi Tau Sigma, were revised slightly to elicit better overall evaluations of instructor performance and effort. The results proved extremely valuable both to the faculty and to the Executive Committee.

The revised curriculum provides greater freedom to students to concentrate either in the traditional disciplines or in the broader aspects of engineering, such as design, systems analysis, and management. The curriculum is intended to serve students who wish to enter
engineering practice upon graduation; to continue on to graduate education and into research, advanced development, or teaching; or to enter interdisciplinary or engineering-related fields. Significant cost savings were realized in the revised program by better coordination and elimination of redundant subject matter while improving the quality of the curriculum.

Undergraduate Office

In a process started a year ago, the Undergraduate Office continued to consolidate administrative matters relating to undergraduate education. Under the able direction of Professor Stanley Backer and Dorothy Eastman, the office coordinates undergraduate registration and counseling, and serves as the primary communications link between the Department and the Registrar's Office, the Schedules Office, and the Committee on Academic Performance. Arrangements for class dinners early in the fall term are organized, and information on student job preferences for the summer is gathered. The office corresponds with potential employers and brings to the attention of students the availability of jobs. The office arranges for B.S. thesis presentations at year end; coordinates UROP activities in Mechanical Engineering; and provides support services for the Pi Tau Sigma subject evaluations, which continue to be valuable tools in making promotion and tenure decisions.

Undergraduate Laboratory

The Undergraduate Laboratory which evolved from the earlier Engineering Projects Laboratory has been further streamlined by disbanding the Undergraduate Laboratory Steering Committee this past year. Its functions were taken over by the Undergraduate Executive Committee. The Undergraduate Laboratory officers, Professor Griffith in the fall term, and Professor Igor Paul in the spring term, provided direction for the Laboratory. Max Donath provided administrative and teaching support as the Undergraduate Laboratory Coordinator. Joseph A. Caloggero, Laboratory Foreman, continued to provide exemplary service to the Department and its students, as he has for the last three decades. This year we are happy to note Mr. Caloggero won the James N. Murphy Award, presented to an employee of M.I.T. 'whose spirited contributions to the Institute family have won a place in the hearts of students.'

The Laboratory was fortunate to receive an $11,500 grant from the National Science Foundation for instructional scientific equipment which is to be matched by the Institute. This is the first time since 1962 that a grant of this type was awarded to the Department. These funds will enable 2.671 Measurement and Instrumentation to augment its program for introducing students to computer controlled experimentation, and 2.672 Project Laboratory to introduce digital measurement instrumentation as part of its program of confronting students with "real life" problems and providing them with the latest tools for their solution.

Undergraduate Committee

Chaired by Professor Borivoje B. Mikic, the Committee continues to function in its restructured form for the second year. The Committee's main role is to provide a broad policy forum for all matters concerning undergraduate life in the Department. A large number of student members ensured strong student input to the Committee. This past year, the topics discussed included curriculum matters, student environment, methods of improved teaching and learning, instructor evaluation, and others. Active involvement by students, who initiated discussions on a number of important issues, led to specific recommendations, which in several cases were adopted by the Department.
Undergraduate Enrollment Committee

Under the direction of Professor Philip Thullen and Mr. Donath, this Committee initiated a series of open houses for freshmen consisting of laboratory demonstrations and informal discussions on topics of current interest in mechanical engineering. The purpose was to convey to freshmen and undesignated sophomores the flavor and excitement of the mechanical engineering profession and to help them make a rational career decision. Total attendance at the three open houses on "Engineering for People," "Energy and Environment," and "Materials, Manufacturing, and Automation," was approximately 50. In addition, many members of the Committee participated in the Departmental presentation at the two academic midways sponsored by the Freshman Advisory Council.

Subjects of Instruction

One of the new subjects developed for the revised curriculum by Professor Argon, with the collaboration of Professor Regis M.N. Pelloux of the Department of Materials Science and Engineering, was 2.34 Structures and Materials - Science and Engineering Case Studies. It is designed as a restricted elective to introduce some advanced topics of applied mechanics such as simple elastic-plastic boundary value problems, creep buckling of bars and finite element methods, together with more advanced topics on the microstructural basis of the constitutive relations for inelastic behavior of engineering metals and alloys. The dual objective of the subject is accomplished by discussing as case studies several well-chosen, complex engineering problems which combine an interplay of materials, mechanics, and micromechanical modeling. The major case study chosen for this year was the nuclear breeder reactor fuel element.

Changes were made in 2.51 Heat and Mass Transfer by Professor Mikic, in collaboration with Professors Griffith and James D. Felske, to bring the subject in line with the curriculum changes. As a restricted elective, it presents introductory material in heat and mass transfer. An effort was made to have a balanced coverage of all modes of heat transfer with equal emphasis on the understanding of the basic mechanisms and applications. The student evaluation as rated by the Technology Community Association, "...one of the Institute's better subjects."

The junior Project Laboratory, 2.672, received major attention this year as it was revised to meet students' suggestions of the year before. Professors B. Shawn Buckley, Griffith, and Thullen, and Mr. Donath restructured the subject with emphasis on major new experiments. Closer supervision and better feedback significantly improved students' reactions to the subject. With the collaboration of Professor Robert R. Rathbone of the Department of Humanities, greater emphasis was placed on improving the writing skills of students. This year's laboratory reports testify to the success of this intensive revamping of a vital part of the laboratory requirements.

Another addition to the list of new restricted electives is 2.96 Management in Engineering developed by Robert T. Lund, Senior Research Associate in the Center for Policy Alternatives and a Lecturer in Mechanical Engineering, and Professor David P. Hoult. The objectives were: 1) to examine the role of engineering and its relationship to other functions such as marketing, finance, manufacturing, and operations; 2) to acquaint students with managerial techniques; 3) to give students practice in managerial problems; and 4) to assist students in career planning. The case study method was used. This subject was well received and should prove to be attractive to many students throughout the School of Engineering.

The two new Undergraduate Seminars offered were 2S12 The How and Why of Electroplating, given by Professor Ernest Rabinowicz, and 2S19 Experimental Phenomena in Fluid Mechanics, given by Professor Ascher H. Shapiro.
Student Life

The two student organizations, the American Society of Mechanical Engineers (ASME) Student Section and the honorary society, Pi Tau Sigma, have continued their active involvement in promoting student/faculty interaction which benefits all concerned. William H. Grace, Jr., a junior in the Department, received the Linde Division of Union Carbide Award for outstanding effort and accomplishment on behalf of the ASME Student Section. Patricia R. Callahan, a senior, was awarded a Compton Prize for outstanding high standards of achievement and good citizenship within the M.I.T. community.

Graduate Program

Enrollment

The number of applications for graduate school in 1974-75 remained nearly the same as in 1973-74, at around 264, with about 77 new students enrolled. The total graduate enrollment as of September, 1974, reached 238 (including special students) compared to 232 the year before. About 27 percent of the current graduate students also did their undergraduate work at M.I.T.; 44 percent have come from other U.S. colleges and universities; and about 29 percent have a foreign educational background. Although our enrollment increased slightly this past year, it is likely to drop in the future because of the shortage of funds for research assistantships and the reduction in numbers of industrial and federal fellowships. This year we lost several outstanding applicants because of the unavailability of financial support. A major problem facing the Department is to find ways to continue attracting the most outstanding students in a time of declining financial resources. The number of assistantships awarded by the Department rose from 121 last year to 143 this year, but unless research funding increases, this number will probably decline. The number of fellowships, always more attractive than assistantships, fell from ten last year to eight this year. We intend to make a concerted effort but no not anticipate much success along this line until the general economic climate improves.

During 1974-75 the Department awarded 84 Master's degrees, 11 degrees of Mechanical Engineer, and 27 doctorates. These figures are identical to those of 1973-74.

Subjects of Instruction

Professor John B. Heywood, in collaboration with Research Associate Dr. Joe M. Rife, has extensively revised 2.615 Advanced Internal Combustion Engines to include recent developments in emissions control and engine design. Several new engine concepts are reviewed to indicate current trends in the field. A laboratory has been added to the subject to give students experience with modern instrumentation and test procedures.

Professor James A. Fry, together with Dr. Alan A. Altshuler of the Department of Political Science and Professor Marvin L. Manheim of the Department of Civil Engineering, has developed 2.66J Transportation and Energy for Greater Boston and New England. The objective of this new subject offering was the analysis of the policy-making process and major issues associated with recent and prospective government decisions on highways, mass transit, deep water ports, and refineries in metropolitan Boston and New England. New perspectives were introduced when Professor Fay and Dr. Altshuler were serving as public officials in Massachusetts and were thus able to discuss current projects being considered by state agencies.
Professor C. Forbes Dewey revised subject 2.173 Instruments for Measurement and Control, changing both the breadth of material covered and the method of presentation, through the use of case studies. Topics covered included resolution, accuracy, and statistical evaluation of measurements, primary measurements, dynamic measurements and industrial process control, signal processing and economic reliability, and failure criteria in instrument design.

Professor Kaufman largely revised 2.737 Kinematic Synthesis of Mechanisms covering new areas of topology synthesis, extended presentations of analytical techniques for dimensional synthesis, and an introduction to dual numbers, dual vectors, and spatial mechanism design. A series of new visual aids was developed to aid in comprehension of the graphical basis for mechanism design. Extensive use was made of the new computer-aided linkage design system, "KINSYN-II."

Student Life

This past year, a remarkable number of graduate students participated in Institute community affairs. Oken M. Amana represented graduates on the Committee on Graduate School Policy. Mr. Donath and Fujio Hayashi were on the Executive Board of the Graduate Student Council. Thomas E. Kenny represented Ashdown House on a housing committee set up to overcome operational problems of the graduate housing system. Frederick Sears and Kenneth Armstead represented the Department and the School of Engineering at a national conference to organize a society of black engineers.

Teaching

Professors David N. Wormley and William J. Shack received teaching awards sponsored by the Graduate Student Council. The two professors were elected by the graduate students for their effective and dedicated teaching of graduate level subjects.

Research

The sponsored research volume for fiscal 1975 is currently projected at $3.48 million, compared with $2.89 million for fiscal 1974. This represents a remarkable increase of 21 percent without adjustment for inflation. These numbers reflect the increasing amounts of time and hard work that faculty put into their research activities, as well as into the necessary proposal writing which often must be done as an extra load.

The scope of the Department's research efforts is highly varied, but can be broadly categorized into four major program areas: 1) manufacturing and materials; 2) energy and environment; 3) bioengineering; and 4) transportation and human services. It is notable that about 30 percent of the Department, in terms of faculty and research volume, is involved in bioengineering, a field which did not exist a decade ago.

The largest area is energy and environment, involving more than 40 percent of our faculty and a third of our sponsored research volume. There is some feeling among the faculty that the manufacturing and materials area is too small, considering the importance of this field to industry and the nation.

Detailed coverage of the specific research projects is not possible in this report; summaries are contained in the full annual report published by the Department.
Department of Mechanical Engineering

Staff

Composition

During the academic year 1974-75, we had a total of 48 full-time regular faculty members: 25 full Professors, 14 Associate Professors (6 with tenure), and 9 Assistant Professors. The resulting tenure/non-tenure ration is 1.82 to 1.

Activities and Awards

Professor Backer served as chairman of the American Section of the Textile Institute and served on the editorial boards of the Textile Research Journal and Fiber Science and Technology. Professors Nathan H. Cook and Stephen P. Loutrel shared the Blackall Machine Tool and Gage Award presented by the American Society of Mechanical Engineers for three separate papers presented on electromechanical machining. Professor Stephen H. Crandall served as vice chairman of the U.S. National Committee for Theoretical and Applied Mechanics and as chairman of the U.S. delegation to the General Assembly of the International Union of Theoretical and Applied Mechanics. Professor Fay continued to serve as chairman of the Massachusetts Port Authority. Professor Heywood was invited to give a paper on automobile emission control at the annual meeting of the American Association for the Advancement of Science. Professor D. Graham Holmes held an appointment as a Lilly Foundation Fellow in educational research. Professor Padmakar P. Lele was elected a Fellow of the Acoustical Society of America for contributions to the science of bioacoustics. He also served on the Board of Governors of the American Institute of Ultrasound in Medicine. Professor Paynter was honored to spend the month of January, 1975, as the Russell Severance Springer Professor of Mechanical Engineering at the University of California at Berkeley. Professor Ronald F. Probstein was elected Councilor of the American Academy of Arts and Sciences for a term of four years and served on the editorial board of the journal Desalination. Professor Warren M. Rohsenow and Professor Emeritus Jacob P. Den Hartog were elected to membership in the National Academy of Engineering. Professor Herbert H. Richardson served as a member of the Policy Board, Research, Executive Committee of the Automatic Control Division, and Chairman of the Transportation Research Goals and Priorities Committee, all of ASME. He also was appointed to the visiting committee of the Lehigh University Mechanical Engineering Department. Professor Shapiro served on the Committee on Science and Public Policy of the National Academy of Sciences and continued as a member of the Board of Governors of Technion-Israel Institute of Technology. He was honored by M.I.T. by appointment to the rank of Institute Professor in recognition of his contributions to the literature and the pedagogy of fluid mechanics. Professor Sheridan was elected to a second year as president of the Systems, Man, and Cybernetics Society of the Institute of Electrical and Electronics Engineers. Professor David Gordon Wilson was a recipient of the "IR-100" presented by Industrial Research for the development of a pilot refuse sorting system, selected as one of the 100 most significant inventions of 1974.

Retirements and Resignations

Professor Shih-Ying Lee retired on August 1, 1974, after 22 years on the faculty of the Department. Professor Prescott A. Smith retired on June 30, 1975, after 30 years on the faculty of the Department, and Technical Instructor Ralph Bowley retired in June, after 46 years of service.
The following resignations were accepted with regret: Professor John P. Appleton, Associate Professors Huw G. Davies and William J. Shack, and Assistant Professor Prabha Sridharan.

HERBERT H. RICHARDSON

Department of Nuclear Engineering

In recent years there have been enormous changes in the worldwide nature of energy production and utilization. The historically long era of cheap abundant energy from fossil fuels, particularly oil, has come to an abrupt end. The alliance of the oil producing and exporting countries has produced a tightly controlled organization which fixes the price of crude oil imported into the United States. The result has been a dramatic increase in the cost of oil and oil products, an increase on the order of 300 percent. The U. S. balance of payments has shifted, almost overnight, from a surplus to a deficit of approximately $15 billion per year. Continued high costs of imported oil promise further economic dislocations in the U. S. and other free-world economies.

American society has felt the effects of the energy crisis in increasing costs of fuel, electric energy, and oil products. Shortages appeared in winter, 1973-74. The response of the Federal government has been to set a national goal of energy independence from foreign sources. Whether or not this can be accomplished quickly is subject to considerable debate. There is, however, uniform agreement among policy planners, energy authorities, and utilities that nuclear power must play an important role in achieving an independent energy supply in the United States. Similar conclusions have also been reached in Japan and most western European countries, particularly France, Germany, and some Scandinavian countries.

Nuclear power has had a continuous growth in the United States since the first commercial reactor went into service in 1958. As of May, 1975, there were 55 nuclear plants with operating licenses. These plants produce 7.9 percent of the U. S. capacity of nearly 450,000 megawatts electric. The nuclear generating capacity now in operation is equivalent to about 1.5 million barrels of oil per day, representing a significant reduction in our nation's need for scarce domestic or expensive imported petroleum. It has been estimated that the total cost saving by the nuclear plants in 1974 amounted to $800 million across the U. S. There are 62 nuclear plants under construction and about 103 plants on order. The combined output of the operating and ordered plants is over 230,000 megawatts electric. It is considered that continued high prices of fossil fuels will lead to even greater reliance upon nuclear power.

Along with the growth of the nuclear industry there is a growth in the need for trained manpower. The American Nuclear Society conducted a survey of the nuclear industry's manpower needs for new graduates in nuclear engineering for 1974-75, the results of which indicate that the demand for S. B. graduates in the U. S. nuclear industry is about four times the yearly generation of new S. B. graduates; for Ph. D. s, the demand is twice the supply.

The shortfall is being met by the hiring of graduates from non-nuclear degree programs who have some nuclear training. It is evident that there is a severe shortage of nuclear engineers today, and the shortage will grow more evident in time with increased activity in the profession. Presently, there are approximately 14,600 engineers employed in the nuclear industry and in nuclear utility and supporting fields, e. g., design, licensing, and construction. The need for 31,000 engineers is expected in the next eight years, a ten percent growth rate. Comparable growth is expected in the needs of the Federal government in the National Laboratory. The manpower demand is not going to decrease from the current level of 2,400 per year, at least not for a decade.
Student recognition of the need for trained nuclear engineers at all levels is apparent in the application statistics in the Department. Applications for admission to the Department's graduate program rose steadily, from 85 in 1972-73, to 150 in 1975-76. The overall enrollment increased steadily from 113 in 1972-73 to an expected enrollment of 150 for 1975-76. The size of our graduate enrollment is limited by the availability of qualified applicants. In the past year, a total of 42 graduate degrees in nuclear engineering were granted, including 33 Masters of Science, three Nuclear Engineers, and six Doctorates.

The aid available to students has increased rather dramatically in the past years. In 1972-73, the Department had a sponsored research volume of $545,000. In 1973-74, the research volume was $734,000, while in 1974-75 the volume is $1.4 million. In academic years 1972-73 and 1973-74, we were able to support an average of 24 research assistants. In 1974-75, we had 48 research assistants, a reflection of the "student intensive" nature of the research within the Department. As a result of the increased research support, we have been able to increase our enrollment. There are indications that Federal support for graduate students, particularly in the crucial area of energy, will increase in the future. Thus, we anticipate further increases in the number of graduate students.

The Department has been fortunate to receive fellowship support from the General Electric Foundation, the Babcock and Wilcox Company, the Northeast Utilities Company, and the proceeds of the Theos J. Thompson Memorial Fund. In addition, we began a cooperative program with the Boston Edison Company in which a student works at Boston Edison for half of his or her time and spends the other half in the Department taking subjects. This program will have continued support next year. The Atomic Energy Commission, now the Energy Research and Development Administration (ERDA), has continued its traineeship program with six trainees.

After considerable planning and preparation, the Department decided to begin an undergraduate program in nuclear engineering. Much consideration went into the construction of an appropriate curriculum for undergraduates, including the possibility of using subjects in other departments for part of the core curriculum to reduce duplication and costs. The proposal was reviewed by the Engineering Council in January, and approved. Subsequently, the faculty in its February meeting approved a recommendation to the Corporation to establish the degree of Bachelor of Science in Nuclear Engineering. The Corporation approved the faculty motion, and the program will begin with the first undergraduates in nuclear engineering enrolling in September, 1975.

Another important development during the year was the evolution of a special program for the training of nuclear engineers from Iran. The Iranian Atomic Energy Organization approached the Institute in summer, 1974, about the possibility of graduate training for nuclear engineers. In spite of its oil wealth, Iran recognizes the need for nuclear power in the future and desires to prepare itself for the day when its fossil resources are exhausted. The Department was unable to take on a large number of students without additional resources. The Iranians had requested a program for 30 students a year. It was finally agreed that no more than 27 students for a two-year Master's program for two classes would be permitted. A special tuition was established for this program to allow the Department to increase its staff and physical facilities to meet the expected addition. This special program is to be considered an experiment. As part of this special program, an independent evaluation of its effects upon our students, the faculty, and the Institute as a whole will be undertaken.

The special program led to considerable discussion on the campus concerning the involvement of M.I.T. in such programs. As a result of the discussions, a special committee was appointed by the President to look at the related institutional commitments.
The academic program in the Department has undergone continued review and revision. In the past year, a number of important modifications to our graduate curriculum have been developed. The most important of these was a complete revision of the subjects in plasma physics and fusion technology. The revision was undertaken to provide training for three distinct types of students: those with a principle interest in fission technology, but desiring some insight into the fusion principles; those with an interest in the engineering and applied aspects of fusion technology; and those students with a career objective in plasma physics and theory. As a result of this effort, three new subjects have been created in the Department, including: 22.610 Controlled Fusion Power; 22.66 Transport Phenomena in Toroidal Systems; and 22.67 Plasma Diagnostics. There also has been a revision of the syllabus with regard to a number of the continuing subjects. The curriculum revision was developed by Professors Lawrence M. Lidsky, Peter A. Politzer, David J. Rose, and Dieter J. Sigmar.

Professors Sow-Hsin Chen and Sidney Yip have revised the basic nuclear physics subjects into a two term sequence. The revision was undertaken to provide nonphysics majors with the opportunity to obtain a comprehensive overview of nuclear physics in one semester. The more theoretical aspects are concentrated in the second semester for students wishing further special training, particularly those in the applied radiation physics option.

The Department was fortunate to have Dr. Thomas A. Jaeger of the Technical University of Berlin as a Visiting Professor for fall term, 1974. Professor Jaeger prepared and taught our first offering in mechanical design, 22.314-315J Structural Mechanics in Nuclear Power Technology. The subject was taught jointly with the Departments of Civil Engineering, Mechanical Engineering, Materials Science and Engineering, Ocean Engineering, and Aeronautics and Astronautics. As a unique experiment in cooperation with many disciplines, the subject was extraordinarily successful, with a registration of 57 students and 23 auditors. Subject material included special tutorials in nuclear power technology for non-nuclear engineering students, and common lectures on mechanical, thermal, and structural analysis of nuclear power plant systems. The format and content of the subject was well received and represents a classic example of how successful interdisciplinary ventures can be. We have a strong motive to continue this subject and search for similar opportunities in other aspects of the nuclear profession.

Professor Irving Kaplan developed a new subject 22.82J The History of Nuclear Engineering: A Case Study in the Interaction between Technology and Society. This subject was presented for the first time in spring, 1975, and represents an acknowledgment of the growing interests in public policy, nuclear energy, U.S. energy policy, and the role of the universities in these broad issues. The subject is both a timely and an important new component of our curriculum.

Professor Norman C. Rasmussen and Professor Elias P. Gyftopoulos introduced a new subject on Reliability Analysis Methods in spring, 1975, growing out of Professor Rasmussen's work and leadership in the study of reactor safety. Reliability problems are intimately related to safety of nuclear plants, and the offering attracted wide graduate and undergraduate attention.

Professor Gordon Brownell revised and condensed our subjects on radiation and shielding in the form of a new subject, 22.534 Radiation Engineering and Shielding.

The M.I.T. Reactor was shut down in May, 1974, for a long-planned modification and overhaul. During its 16 years of operation, M.I.T. students, faculty, and staff have generated nearly 1,000 theses, journal articles, and reports related to the MITR-1. Also, 33 other universities and research centers, five hospitals, and 44 industrial firms have used the reactor during that period. At the time of shutdown, the reactor had logged 63,083 operating hours at full power.

The purpose of the modification is to modernize the reactor facility and to provide improved neutron fluxes in the beam ports, along with better "signal-to-noise" ratios. The new design,
which provides for this upgrading without any increase in power above the previous five mega-
watts, incorporates a more compact core cooled by light water and reflected on the sides and
beneath by heavy water. This modification required new fuel, core and reflector tanks, con-
trol blades and drives, process piping, and some shielding. Most other existing components
have been retained, including the graphite reflector, thermal shield, biological shield, heat
exchangers, pumps, cooling towers, instrumentation, and containment building.

Following the issue of a Nuclear Regulatory Commission license for operation of the MITR-II,
the plan is to perform startup tests and to escalate to five megawatts during summer, 1975.
Thereafter, the reactor will resume its normal operating schedule of 100 hours per week,
Monday through Friday, for the various programs already scheduled in neutron diffraction,
molecular dynamics, fast reactor physics, geology, biomedical applications, and others.
The reactor modification has been under the supervision of Research Associate Lincoln Clark,
Jr., and Professor David D. Lanning.

The reactor will begin operating as a separate M.I.T. laboratory in the 1975-76 academic year,
and will no longer be part of the Department of Nuclear Engineering. This separation has been
planned for several years and is being implemented to improve efficiency, reduce administra-
tive problems, and highlight the reactor's role as a true Institute-wide facility.

Research in the Department has expanded considerably to a new high level of $1.4 million, as
mentioned previously. Among new Department projects are the following:

1) Reactor Transient Analysis Code - Electric Power Research Institute -
   Professors Michael W. Golay, Kent F. Hansen, Allan F. Henry, and
   Neil E. Todreas;

2) Arms Control - Ford Foundation - Professor Rasmussen;

3) Fusion Technology - Energy Research and Development Administration -
   Professors Arden L. Bement, Golay, Lidsky, Politzer, Rose, and
   Todreas;

4) Plutonium Recycle in PWR Cores - Yankee Atomic Power Company -
   Professor Lanning;

5) Nuclear Reactor Materials - General Electric Company - Professor
   Bement;

6) Small Brayton Cycle HTGR - U.S. Army - Professors Michael J.
   Driscoll, Golay, and Lanning;

7) Computer Simulation Studies - U.S. Army - Professor Yip;

8) Plume Disposal - Energy Research and Development Administration -
   Professor Golay;

9) Accident Probability Analysis - General Atomic Company - Professor
   Lanning;

10) Health Implications of Energy Technology - National Science Foundation -
    Professor Rose;

11) Reactor Physics Constants - Electric Power Research Institute -
    Professor Allan F. Henry;
In addition to these new projects, a number of continuing programs have been carried out at an active level. Professors Henry and Hansen have continued work sponsored by ERDA on numerical methods for analysis of reactor transients. Professor Henry also has directed work sponsored by the Combustion Engineering Company on light water reactor theory. Professor Driscoll continues to lead an ERDA-sponsored project on fast reactor blanket analysis and experimentation. Professors Manson Benedict and Edward A. Mason have been directing research on the nuclear fuel cycle, particularly the economics, planning, and analysis of fuel management methods. The work has been sponsored by Commonwealth Edison Company and American Electric Power Company. Professors Yip and Chen have directed a program of experimental studies in neutron scattering on hydrogen-bonded solids, with sponsorship from the National Science Foundation. In addition, Professor Yip has begun further studies of the molecular dynamics of solids and chemically reacting systems. Professor Bement has been working on nuclear materials research, including deformation and fracture behavior of zirconium alloys, as well as the critical materials problem for advanced high temperature gas-cooled reactors. Professor Golay has been working on a series of problems relating to engineering effects of nuclear power, which include such areas as cooling tower drift modeling and elimination, coupled thermal-electrical systems, and thermal-hydraulic modeling. Professor Todreas continued research on thermal analysis in the areas of coolant energy mixing in rod bundles, numerical simulation of convective heat transfer, thermal design of fusion reactor systems, and the treatment of uncertainties in reactor thermal analysis. The work is supported by ERDA and the General Atomic Company. Professor Gyftopoulos continues work on thermodynamics in collaboration with Dr. George Hatsopoulos, Senior Lecturer in the Department of Mechanical Engineering. Much of the work was in developing a new approach to the teaching of the basic engineering principles subject in the Department. Professor Gyftopoulos and his students also have been working on the application of Markovian theory to reliability and availability analysis. Professor Kaplan has continued research in the area of the history of atomic theory and the general subject of history and technology. Professor Kaplan also has been a member of the undergraduate alternative education program, Concourse.

The increased interest in thermonuclear power has been reflected in the research activities of Professors Lidsky and Politzer regarding plasma experimentation and diagnostics. Professor Lidsky also has continued to serve as a member of the advisory committee to the Alcator Experiment. Professors Thomas H. Dupree and Sigmar have continued work in the area of plasma theory and dynamics.

The faculty in the Department continues to be very active in the direction of special summer programs. These are high level, intensive subjects in which special training is offered to
persons outside the Institute. The most popular such subject, in view of the number of partic-
icipants, is the subject on Nuclear Power Reactor Safety, directed by Professors Rasmussen
and Bement. Professor Rose is in charge of a two-part program on Energy, A Unified View,
and Strategic Planning in the Energy Sector. Professor Brownell directs a one-week program
on Physical Aspects of Nuclear Medicine. Professors Hansen, Mason, and Benedict sponsor
a two-week program on Nuclear Fuel and Power Management. A new additional program is
planned to be offered for the first time in summer, 1975. It concerns Structural Mechanics in
Nuclear Power Technology, and is being organize by Professors Jaeger and Todreas with the
assistance of Professor Jerome T. Connor, Jr., of the Department of Civil Engineering, and
Professor Theodore H. Plan of the Department of Aeronautics and Astronautics.

The Department had an active Independent Activities Period (I. A. P.) program in January, 1975,
when a total of 12 offerings were presented. These included the following, which were given on
an Institute-wide basis:

1) Nuclear Power: An Open Discussion of the Issue, conducted by students
   in the student chapter of the American Nuclear Society.

2) A Beginners Guide to Gambling, or How to Lose Intelligently at Las
   Vegas, conducted by Professor Hansen.

3) Nuclear Intervenors Interviews, organized by students, consisting of
   field trips to various locations in New England where there has been
   opposition to the siting of nuclear plants.

4) Numerical Methods of Fluid Flow Calculations, a series of lectures
   presented by Dr. C. W. Hirt of Los Alamos Scientific Laboratory.

5) Controlled Thermonuclear Fission: The Search for a New Energy
   Source, conducted by Professors Dupree, Lidsky, Politzer, Rose,
   and Sigmar. This was a set of lectures over a two week-period
   which surveyed the control thermonuclear scene from basics to de-
   sign and was well attended.

6) Neutron Molecular Spectroscopy, conducted by Senior Research
   Associate Charles Berney and T. Postal, a graduate student.

7) An Afternoon at the Physics Research Laboratory, conducted by
   Research Associate Brian W. Murray, consisting of a tour and dis-
   cussion of work going on at the Physics Research Laboratory at the
   Massachusetts General Hospital.

8) Can a Five Megawatt Reactor Find Fulfillment in Medicine? conducted
   by Drs. Murray and Don Hnatowich, discussing the application of reactor
   neutrons in the medical field.

There were, in addition, a number of activities which were open to members of the Depart-
ment only, including a work-study program for several weeks at the Boston Edison Pilgrim
Nuclear Power Station, a seminar on the nuclear code facilities in the Department, an informal
discussion of nuclear power reactor safety by Professor Rasmussen, a lecture on the twin
paradox of special relativity, work projects at the M.I.T. Reactor during the redesign, and
a discussion on time travel at a joint seminar sponsored by the Departments of Nuclear
Engineering and Philosophy.
Faculty Activities

The faculty in the Department have been active in professional activities outside the Institute which contribute to the general welfare of the professional societies and the nation as a whole. Professor Todreas has been elected chairman of the American Society of Mechanical Engineering Heat Transferred Division Committee on Nucleonics Heat Transfer. Professors Chen and Yip organized an international symposium on nuclear power technology and economics, which was held in Taipei from January 13-21, 1975. This symposium was sponsored by the National Science Council of the Republic of China. Three members of the Department, Professors Benedict, Bement, and Rasmussen, presented papers at this symposium. Invited papers were also given by two members of the Department Visiting Committee, Dr. W. B. Lewis and Dr. A. M. Weinberg. Professor Rasmussen has maintained active outside professional activities as a result of the publication of the Reactor Safety Study, WASH-1400. He has become the leading spokesman throughout the world on the issues of nuclear reactor safety. He has made numerous presentations to universities, industries, utilities, professional societies, state legislatures, and others. Professor Rasmussen has spoken in ten different foreign countries as part of his activities in this vein. Professor Rose served as a consultant to the Congressional Office of Technology Assessment with regard to the budget of ERDA. In addition, Professor Rose participated in the National Academy of Science Committee on mineral resources in the environment. He also serves as the chairman of the visiting committee of the Department of Applied Sciences at the Brookhaven National Laboratory. Professor Driscoll was elected to the executive committee of the Reactor Physics Division of the American Nuclear Society. Professor Gyftopoulos was elected as chairman of the Honors and Awards Committee of the American Nuclear Society.

Honors and Awards

The faculty also have received numerous honors for their efforts in the past year. Professors Driscoll and Todreas received an award from the M.I.T. Graduate Student Council for effective teaching. In addition, Professor Driscoll received the outstanding teacher award in the Department from the student branch of the American Nuclear Society. Professor Henry completed his text on Nuclear Reactor Analysis which will be published in June by the M.I.T. Press. Professor Yip was elected the 1975 Distinguished Alumnus, from the University of Michigan Department of Nuclear Engineering. Professor Gyftopoulos served as Chairman of the M.I.T. Faculty for the past two years. Professor Kaplan was elected Secretary of the Faculty for two years beginning July 1, 1976. Professor Rose received the Arthur Holly Compton Award from the American Nuclear Society. He is the third faculty member of the Department to receive this award, past recipients being Professors Benedict and Kaplan.

Resignations and Promotions

Professor Mason resigned as Head of the Department on January 19, 1975, and took a leave of absence from M.I.T. in order to serve as a commissioner of the Nuclear Regulatory Commission. Professor Mason served as Head for three and one-half years. In that time the Department reached new levels of enrollment, faculty size, curriculum development, and research funding. Professor Mason will be missed sorely and hopefully will return to M.I.T. after his period of service in Washington. Professor Hansen served as Acting Head until the end of the academic year. Professor Rasmussen will become the new Head of the Department on July 1, 1975. After six years of service on the faculty, Professor James W. Gosnell is resigning to accept a position in industry. Professor Gosnell has been an important contributor to our academic program, while also serving as Assistant Director of the M.I.T. Reactor.

KENT F. HANSEN
The Department has completed its eighty-first year, with strength and vitality. It continues its dedication to the broader aspects of ocean engineering, including marine resources, offshore platforms, and ocean measurement systems, as well as to naval architecture and marine engineering.

**Academic Highlights**

The student body of the Department is at a level nearly equal to its all-time high reached last year. Degree candidates now number 196, one less than in 1973-74. Undergraduate enrollment increased from 37 to 40, while graduate enrollment decreased from 160 to 156. It is believed that the decrease in graduate enrollment is within the bounds of the expectation that it would stabilize at about 160.

Approximately two-thirds of the graduate students are following programs that are ship related, and about two-thirds of those admitted this year also have expressed similar interests. While such distinctions are not as useful in the undergraduate program when career choices are not as firm, it appears that undergraduates do not quite share this interest since only about 40 percent are ship oriented. In brief, the Department continues its commitment to students with varied interests.

Individuals within the Department have maintained active roles in the freshman advising process, and the Department has tried to improve its visibility to the uncommitted undergraduates through activities such as undergraduate seminars, I.A.P. offerings, and academic midway displays. It is hoped that these efforts will continue to attract an increasing number of undergraduates to the Department.

Three new undergraduate subjects are being prepared for presentation in 1975-76. These are: 13.011 Hydrostatics, 13.91 The Sea and Society, and 13.97J Introduction to Technology and Law. In addition, a subject offering in dynamics, which has been taught by the Department of Mechanical Engineering, will become a joint offering, with the new number 13.003J. Finally, 13.901 Ocean Engineering Laboratory is being restructured so that the work for academic credit is performed at M.I.T. during the regular academic year. Previously, academic credit had been given for the field work portion of this offering during the summer.

The Cooperative Work-Study Program (Course XIII-C) continues its slow but steady development. The cooperating organizations include the American Bureau of Shipping, the Naval Underwater Systems Center, and Westinghouse Corporation. Avondale Shipyard is still negotiating with us for inclusion in the program. The Department is seeking a participant that is involved in the offshore oil business.

New graduate subjects being developed for the coming year include: 13.06J Nonlinear Wave Propagation; 13.35 Ship Structural Analysis and Design; 13.95 Offshore Petroleum Exploration and Development; and 13.996 Design of Oceanographic Mechanical Systems. Also, the Department's design offerings have been consolidated and revised to reflect the needs of students entering today's professional environment in naval ship design. The subjects as now configured...
School of Engineering


Research

The Department's research efforts continue to be well received, and under the present economic situation, decently funded. Content of the research seems to match nicely the career interests of our students. Also, virtually all sectors of faculty interest are supported through sponsored research contracts. It is appropriate to report, as in the past, that our faculty continue to exert national if not international leadership in the areas of their expertise.

Some new research projects may be of interest. The selections given here are intended to display the range of research activities:

1) Inspection technique for offshore platform structural failure;
2) Failure of a large controllable pitch propeller;
3) Procedure for evaluating comparative air, water, and interface vehicles;
4) Hydrodynamic interaction of two ships close to each other in shallow water;
5) Sailing performance of yachts;
6) Alternative policies for managing the Georges Bank fishery.

The Towing Tank was very active again this year in student laboratories and theses, sponsored research, commercial testing, and demonstrations. There was significant use of the tank facilities by students of the Department of Civil Engineering in its subject, Water Resources Laboratory Project. In addition, as in the previous years, the tank facilities were made available to students of the University of New Hampshire and the U.S. Coast Guard Academy. Several demonstrations were carried out for special visitors and high school groups.

The facility will be closed during August, 1975, for extensive maintenance which consists of complete cleaning and painting of the tank, repair and improvement of instrumentation, and the realignment of the carriage rails. During the year, the equipment and methods for digitalizing and spectrally analyzing seakeeping data were updated and improved. Research and development tests were performed for ten different companies or institutions, including General Dynamics, EG&G, and Bird-Johnson. Professor Martin A. Abkowitz is Director of the Ship Model Towing Tank, and will represent the facility at the forthcoming International Towing Tank Conference to be held in Ottawa, Canada, in September, 1975.

The Variable Pressure Water Tunnel experienced a substantial increase in both academic and sponsored research activity. In spite of this, financial limitations have made it extremely difficult to maintain and improve the equipment in the laboratory to the extent required for performing high quality experimental work.

Current student projects in the Marine Data Systems Laboratory include the design, construction, and development of a computer-controlled robot submarine. This device was tested on
a tether at Castine, Maine in July, 1974. Other projects include a large model of an ocean mining device and the frequency and amplitude of strumming cables in the ocean. Professor Alexander D. Carmichael is in charge of this effort.

Initial plans for the Design Laboratory started in 1971, and major new proposals to the National Science Foundation (NSF) for support were submitted in 1972. During fiscal year 1974, research in the areas of offshore platforms and surface effect ships commenced. These efforts were supported by Sea Grant and the U. S. Naval Ship Research and Development Center respectively. For fiscal year 1975, the following research is active in the Department's Design Laboratory:

1) A study supported by NSF to develop aids which will improve design instruction in naval architecture. This work is being done in collaboration with the University of Michigan and Webb Institute.

2) The Sea Grant study of offshore platform design, with special emphasis on multipurpose platforms.

3) A study to develop a new procedure for evaluating water, air, and interface vehicles, supported by the Advanced Research Projects Agency, is expected to conclude in fiscal year 1976.

A new X-Y digitizer has been received and is expected to enhance the minicomputer capabilities of the laboratory. Professor Chryssostomas Chryssostomidis is in charge of this facility.

The Commodity Transportation and Economic Development Laboratory (C. T. E. D. L.) has become a Department activity. Until this year it functioned as an interdepartmental laboratory, but the Center for Transportation Studies now fills that role. The C. T. E. D. L. is functioning as one of the associated organizations of the interdepartmental Center for Transportation Studies. Its prime objective will be to perform research in commodity transport with special reference to international transport and its effect upon economic development. Its role in the Department will be to provide a forum for faculty and students interested in problems related to ocean transport, pipeline transport, port and terminal development, offshore exploration and exploitation, international trade, commodity distribution and storage, integrated point to point transportation, transport routing and scheduling, development economics, maritime policy, commodity transport pricing and regulations, and similar subjects. The Laboratory, as a result, serves as an activity in which research is coordinated to measure the impact on an overall commodity transport system and its requirements.

Faculty

The Department has increased its faculty by the addition of Edward C. Kern, Owen H. Oakley, and Ronald W. Yeung as Assistant Professors. Associate Professor Arthur B. Baggeroer has held a joint appointment with the Departments of Electrical Engineering and Computer Science and Ocean Engineering, with the former being his home department. He will shift his primary affiliation to the Department of Ocean Engineering in the coming academic year. Associate Professors Norman Jones and Jerome H. Milgram were granted tenure at the beginning of this academic year. Professors Koichi Masubuchi, Jones, and Milgram have been on sabbatical leave this past academic year. The Department was fortunate to have two visiting staff members: Dr. Celio Taniguchi from the University of Sao Paulo, Brazil, and Oddvar Frydelund from Det Norske Veritas in Norway.
Other Initiatives

Professional Summer

The Professional Summer is a program of professional subjects organized and developed by the Department and the Charles Stark Draper Laboratory. The subjects are intended for officers and civilian personnel working in systems design and analysis within technologies important to the U.S. armed services.

The Professional Summer has been developed to meet the needs of Navy graduate students (Course XIII-A), and to provide other qualified students with an opportunity to study and discuss technical issues important to the armed services. Lecturers come from a variety of technical areas, including the armed services organizations, industry, and academia.

The 1974 Professional Summer consisted of six subject offerings and a three-day workshop. A seventh offering, Gas and Ball-Bearing Technology, was withdrawn. This summer's program will begin on June 2, and will extend through August 15. It includes six subjects: Submarine Design Practice; Naval Surface Ship Design; Advanced Marine Vehicles; Weapons Effects and Ship Protection; Sensors, Instrumentation, and Control for Combat Systems; and Surface Ship Combat System Design.

1976 International Ship Structures Congress

At the 1973 meeting of the International Ship Structures Congress in Hamburg, Germany, the United States was formally designated the host country for the 1976 Congress, with Professor John H. Evans as chairman. The Congress will be held at M.I.T. and is to be funded by the American Bureau of Shipping, the Maritime Administration (MARAD), and the Ship Structures Committee.

A meeting of the standing committee was held in April, 1974, in Venice, Italy. Another will be held in Oslo, Norway in June, 1975. Plans are proceeding satisfactorily, and technical committee reports for publication and discussion are expected in October, 1975.

Marine Archeological Workshop

The Department hosted a "Marine Archeology Workshop" on February 11, 1975. The technological and scientific problems of marine archeology were explored. The topics discussed included the technology of search and survey, the historical aspects of ship construction and naval architecture, preservation of artifacts, and a case study, Search for the Defense. Presentations were made by Lecturer William A. Baker and Senior Lecturer Captain Willard F. Searle of this Department, Professor Harold Edgerton of the Department of Electrical Engineering and Computer Science, representatives of the Institute of Nautical Archeology, and the Maine Maritime Academy.

Events of Special Interest

New Texts

Faculty in the Department are authors or coauthors of the following new texts: Parable Beach: A Primer in Coastal Zone Economics to be published in late 1975 as part of the M.I.T. Sea
Grant Series of texts (Professor John W. Devanney III, G. Ashe, and B. Parkhurst); and Ship Structural Design Concepts, published by the Ship Structural Committee and to be republished by Cornell Maritime Press (Professor Evans, editor and co-author Professor Alan Mansour, and other co-authors).

Public Service

The Department is pleased to report that the following faculty members have been appointed to the indicated committees, boards, and panels during the preceding 12 months: Professor Abkowitz, member, Design Review Board, Naval Coastal Systems Laboratory; Professor Carmichael, chairman, Controllable Reversible Pitch Propeller Review Panel, Naval Sea Systems Command; Professor Chryssostomidis, member, Advisory Group I, Ship Structures Committee, National Academy of Sciences; Professor Ira Dyer, chairman, Panel on Ocean Engineering Navy Oceanographic Program, Marine Board, Assembly of Engineering, National Research Council; and Professor Masubuchi, member, Panel on Underwater Electrical Safety Practices, National Research Council.

International Educational Activities

Professor Jones spent the spring term on sabbatical leave in residence at the University of Manchester, Manchester, England. Professor Masubuchi spent the spring term on sabbatical leave in residence at the University of Tokyo, Tokyo, Japan. Professor Milgram spent the entire academic year on sabbatical leave collaborating on research at Harvard University.

Honors and Awards

Professor Judith T. Kildow was awarded a Lilly Teaching Fellowship for the academic year 1974-75. Professor Kildow was also appointed to the Editorial Board of the Coastal Zone Management Journal. Professor Patrick Leehey was elected a Fellow of the Acoustical Society of America. Professor Masubuchi was honored to become the Clarence E. Jackson Honorary Lecturer of the Washington, D.C., Section, American Welding Society.

Industrial Liaison Office Symposia and Seminars

The Department faculty participated in an Industrial Liaison Office Symposium. Professor J. Daniel Nyhart chaired the meeting, and participants included Professors Dyer, Kildow, Chryssostomidis, Devanney, and Henry S. Marcus. The topic of the symposium was Offshore Installations: Legal, Technical, Policy Considerations.

Francis Russell Hart Nautical Museum

Largely because of the country's Bicentennial celebration, the number of research visitors to the Hart Nautical Museum, and the volume of mail and telephone inquiries received, have increased considerably during the past year. Beginning in December, 1974, and continuing through April, 1975, the museum's staff was working with the Museum of the American China Trade, Professor B. W. Labaree of Williams College and others in the production of a short audiovisual maritime history of Boston to be shown during the Bicentennial at the Boston Aquarium. Photographs of lithographs, engravings, and models from the Hart Nautical Museum will appear in the final production. A wind tunnel model of a 12-meter yacht will be displayed in a special two year Bicentennial exhibition at the Prudential Center.
During 1974-75, other museum plans and photographs were published in the Catboat Association's *The Catboat Book*, David MacGregor's *Fast Sailing Ships 1775-1875*, the "Nautical Research Journal," and the *National Fisherman*. Other photographs were supplied to the National Park Service, the Science Research Association of Chicago, and to a number of private collectors.

A surge of interest in the museum's Forbes Collection of whaling prints is expected to follow the display of a few of them at Boston's Museum of Science in connection with a special weekend symposium and exhibition on whales held in April, 1975.

Two new models have gone on display: the 1/32" scale waterline model of the 250,000-ton deadweight tanker *Esso Gascogne*, and the 1/8" scale full model of the 1889 fishing schooner *Fredonia*. The VLCC *Esso Gascogne* presents a striking contrast to the model of the first oceangoing tanker *Gluckauf*, several of which could be carried on her deck. The *Fredonia* fills one of the gaps in the museum's fishing boat collection. Designed by Edward Burgess, she was an important vessel in the history of the American fishing schooner, a move away from the dangerous shallow-hulled clipper type. The *Fredonia*'s characteristics were copied widely by other fishing schooner designers. This model by Erik A. R. Ronnberg, Jr., of Rockport, is an exquisite example of the modelmaker's art.

Also on display during the year is a model of a Piscataqua River gondola deposited by Harry A. Precourt of Dover. While gondola -- the term had many spellings and pronunciations -- were ubiquitous in New England waters, the Piscataqua River variation was unique. These craft were the trucks of the nineteenth century, carrying all sorts of commodities of the Piscataqua River and the inland bays and rivers connected to it.

As a Bicentennial exhibit, the first floor wall panels in Building 5 now show a series of reproductions of paintings and other items pertaining to various naval actions in the War for Independence. Most of these were supplied by the Navy Department's Director of Naval History. As the Bicentennial celebration progresses, the museum's models of vessels of the 1770s will be displayed together in one case.

Short-term exhibits during the past year have included pictorial and other material pertaining to the Penobscot Bay summer projects sponsored by the Department of Ocean Engineering: large tanker maneuvering, oil drilling, the Boston Tea Party, finding the U.S.S. *Monitor*, and the "Great M.I.T. Boat Race," an I.A.P. project.

The curator gave his usual well-received lectures on the history of ships for I.A.P. in January, 1975. Other lectures on various subjects were delivered during the year at the Bath Marine Museum and the Morse High School, Bath, Maine; the Hingham Historical Society; Mystic Seaport; an Ocean Engineering Tankard Seminar; and for Professor Kildow's seminar on Sea and Society: the History of Marine Technology and Power Politics.

Conservation work during the year included protecting all prints by interleaving with thin acid-free paper as recommended by the Museum of Fine Arts, and sorting and filing Professor George Owen's plans in acid-free folders.

Gifts to the museum include two rare photographs of the U.S.S. *Monitor*; a set of plans for the fishing schooner, *Benjamin W. Latham*; four large color photographs of Marathon-built offshore drill rigs; nine color photographs and eight color prints of drill rigs and tankers from the Exxon Corporation; 20 prints from the Director of Naval History; and several books. To improve the museum's reference services, 11 books were purchased, several of which were offered by the San Francisco Maritime Museum.
In fall, 1974, the Peabody Museum of Salem published P. C. F. Smith's *The Frigate Essex Papers*, which included four plans of the frigate drawn by the curator, and "The American Neptune" for October, 1974, contained the curator's article on "Gosnold's Concord and Her Shallop." The curator's two-volume *A Maritime History of Bath, Maine, and the Kennebec River Region* received an Award of Merit from the American Society for State and Local History.

IRA DYER

**Center for Advanced Engineering Study**

During the 1974-75 academic year, the Center for Advanced Engineering Study (C.A.E.S.) has continued to provide conventional engineering education for midcareer engineers from industry, government, and academic institutions of the U.S. and foreign countries. Continuing technical education was offered both at M.I.T. through on-campus programs and at the place of employment through self-study videotaped packages. In addition, the Center continued and broadened its services to the Institute through television production, video equipment rentals, film activities, and the new telecommunications project.

Dr. Myron Tribus joined the Center as Director on January 1, 1975. The central administration continued this year under the guidance of Evelyn T. Christiansen, Assistant to the Director of C.A.E.S., and Linda E. Ward, Administrative Assistant.

**On-Campus Programs**

The on-campus education programs of the Center continue to provide experienced men and women the opportunity to spend one or more academic terms at M.I.T., pursuing studies tailored to their needs and the objectives of their employers or sponsors.

There are four core on-campus programs: the Advanced Study Program, the Advanced Study Program in Air Transportation, the Advanced Study Program in International Nutrition Planning, and the Education for Public Management Program. C.A.E.S. offered 12 special subjects specifically for the Fellows of these programs. Also a special six-week intensive review of mathematics was offered during the summer.

Altogether there were 55 Fellows, 18 more than last year, from 14 countries in addition to the United States: Bangladesh, Barbados, Belgium, Brazil, Canada, Ecuador, Ethiopia, Germany, India, Israel, Italy, Japan, Pakistan, and Zambia.

There were 40 Fellows in the Advanced Study Program (11 more than last year), seven in the Education for Public Management Program (same as last year), three in the Advanced Study Program in Air Transportation (two more than last year), and five in the Advanced Study Program in International Nutrition Planning (five more than last year). Our principal concern is with the small number of Fellows from U.S. industry. Seventy-five percent of this year's Fellows came from foreign organizations. Of those from U.S. organizations, only two came from U.S. industry (the remainder from U.S. government agencies or nonprofit organizations).
Foreign Programs

C.A.E.S. began the Technology Training Program for the Republic of China in January, 1975. This is a two-year education program to provide academic studies and "hands on" development projects for a group of 15 participants sponsored by the government of the Republic of China. The program is offered in conjunction with the Department of Aeronautics and Astronautics and the Charles Stark Draper Laboratory. This year, these Fellows attended three special subjects that were offered specifically for them, and they spent part of each day working on their project at the Draper Laboratory. Next year, they will attend regular Institute subjects as well as additional special subjects related to their project.

The Center also joined with the Department of Nuclear Engineering in the special program with the Iranian Atomic Energy Organization for the special training of graduate students in nuclear engineering. The Center will arrange special subjects in English and mathematics during the summer for these students as well as provide services similar to those offered our Fellows, special social events, personal and academic advising.

Computer Facility

In January, 1975, the decision was made to sell the IBM 1130 to the Department of Chemical Engineering. The Dartmouth Time Sharing System (DTSS) was chosen as the most viable replacement, offering a wide range in software systems and ease of use. A fixed fee contract to provide two terminals and dedicated access to the DTSS was negotiated with the New England Regional Computing Program (NERCOMP) through which Dartmouth is a supplier of timesharing resources to the educational community. We were pleased to find the problems of system change in midyear to be minimal, and indeed computer use increased during the second term of this year, from 309 hours in the first term when the old computer was in use to 819 hours. Sixty percent of the Fellows in on-campus education programs used the facility during the spring term. C.A.E.S. on-campus programs were under the direction of Dr. Paul E. Brown, Assistant Director, C.A.E.S. The computer facility is managed by Marjorie L. Hanson of the C.A.E.S. staff, under the general direction of Dr. Brown.

Self-Study Programs

During academic year 1974-75, study guides for eight new self-study subjects were completed, and marketing for the finished packages began. New packages on the market are: Colloid and Surface Chemistry, Part 4, (Lyophilic Colloids,) by Visiting Professor J. T. G. Overbeek, Department of Chemical Engineering; Friction, Wear and Lubrication, by Professor Ernest Rabinovich, Department of Mechanical Engineering; Modern Control Theory, Part I, (System Analysis,) and Modern Control Theory, Part II, (Deterministic Optimal Control,) by Professor Michael Athans, Department of Electrical Engineering and Computer Science; Economics, Part I, (Microeconomics,) and Economics, Part II, (Macroeconomics,) by Assistant Professor Robert Pindyck, Sloan School of Management; Artificial Intelligence, by Associate Professor Patrick Winston, Department of Electrical Engineering and Computer Science; and Mechanics of Polymer Processing, Part I, (Introduction,) by Visiting Professor J. R. A. Pearson, Department of Chemical Engineering.

In addition, Mechanics of Polymer Processing, Part II, (Fundamentals of Polymer Melt Mechanics,) is completed and will go on the market during the summer. Other packages in the final stages of development are Modern Control Theory, Part III, (Deterministic Optimal Linear Feedback,) Part IV, (Stochastic Estimation,) and Part V, (Stochastic Control); Mechanics of
Polymer Processing, Part III, (Applications to Polymer Processing); and Digital Signal Processing, by Associate Professor Alan Oppenheim, Department of Electrical Engineering and Computer Science.

Our principal concern with respect to the self-study program is its apparent inability to recover costs and, hence, the necessity to stop further internally funded subject development. We have initiated no new package development during the fiscal year and soon will have completed all subjects currently under development. Several alternative means of financing subject development are being explored: seeking development grants from prime users, be they industries or M.I.T. departments; cost and profit sharing with M.I.T. departments; and lowering C.A.E.S. videotaping charges to a level that would attract department initiated subject development.

Self-study programs are under the direction of John T. Fitch, Manager of Self-Study Package Development, C.A.E.S.

Evaluation

The evaluation group, formed last year to address the issues and problems arising in the distribution and use of self-study materials, continued this year. Professor Judah Schwartz, School of Engineering, and Eunice Moo, Educational Development Center, Inc., devised a new form of questionnaire to be used with the self-study package, Surface Chemistry, incorporating questions on attitudinal and background information as well as substantive information on students' technical competence in the subject area of the package. Follow-up visits and interviews were conducted at two industrial sites. Conclusions from the evaluation effort continue to confirm that the M.I.T./C.A.E.S. self-study packages are considered among the best available. However, the guidance and counseling mechanisms and the channels for transmission of information about opportunities for continuing education to the practicing engineer in industry are inadequate.

Marketing

With the addition of the eight new subjects listed previously, the number of subjects distributed by C.A.E.S. increased this year from ten to 18. The new subjects did not become available early enough in the fiscal year to effect our total revenue picture, but should be apparent next year. C.A.E.S. self-study packages were used by 1,310 students this year and 45 different organizations. Out of 33 major orders during the year, seven were from organizations which had not used our subjects before. There was a large increase of multiple subject users (25 out of a total of 48, up from 14 out of 41 last year); but only a small number of organizations reused a subject they had had before (six out of the 33 major orders). Multiple subject users since the inception of the program are distributed as follows: 30 firms or divisions have used one subject; 14 firms or divisions have used two; seven firms or divisions have used three; three firms or divisions have used five subjects; and two have used seven. Of the seven new firms, two were nonprofit, one was a foreign company, and four were industrial corporations. The distribution of self-study materials was under the direction of Arthur Collias, Manager of Self-Study Subject Distribution.
Video and Film Activities

Video Services Production

Again, the major use of the broadcast quality color facility during 1974-75 was in the recording of C.A.E.S. self-study subjects. However, the elimination of internal funding of new subjects has decreased the use of this facility substantially. Among the major color recordings for non-C.A.E.S. clients was the taping of "Engineering in the 70s," a conference for secondary school mathematics and science teachers sponsored by the School of Engineering.

The production of black and white videotapes increased fourfold over the preceding year. Major productions were ten lectures by Professor Hans-Lukas Teuber, Department of Psychology, of 9.00 Introductory Psychology, and nine lectures sponsored by John Wynne, Vice President for Administration and Personnel, of the I.A.P. Seminar, "M.I.T. -- The Institution."

There is some concern about the simultaneous decrease in the use of our color facility and increase in the simpler black and white facility. There are two types of concern: one of relative price, that the high cost of two inch color production is prohibitive to departments with ever decreasing budgets; and one of degree of sophistication, that in an educational environment, broadcast quality is unnecessary, so a lower quality, easy-to-use color facility would be desirable.

Several other services were provided: 1) duplication of recordings primarily for the distribution of self-study subjects; 2) the rental of television equipment, particularly to participants in the telecommunications project supported by the new grant from the Sloan Foundation; and 3) electronic editing of two inch video recordings primarily for new C.A.E.S. tapings, but also for WGBH-TV. A different sort of service was provided this year for the first time, due to the establishment of the black and white experimental studio last year, resulting in the use of the facility on a regular basis by several departments in their instructional programs. The departments and subjects taught were: 4.094, the Department of Architecture; 11.943, the Department of Urban Studies and Planning (with Boston University); 21.902 and 21.119, the Department of Humanities; MS-221, Army ROTC; and thesis work by graduate students of the Department of Urban Studies and Planning.

These various services were provided under the direction of Jerome H. Adler, Manager of Video Services, C.A.E.S.; Mr. Fitch, and James R. Roberts of the Center staff.

Video Facilities

A second one-half inch editing system was purchased during the 1974-75 academic year with funds provided by the new Sloan Grant for Telecommunications. This facility will provide more efficient service to users of portable video equipment, both black and white and color, and to users of the black and white experimental studio, primarily participants in the telecommunications project. The installation of this new equipment, and the maintenance of all C.A.E.S. television equipment, was performed under the direction of Charles D. Paton, Chief Engineer, C.A.E.S.

Film Unit

The film "Women's Work: Engineering" was completed during the 1974-75 academic year. It was funded by the School of Engineering, IBM, and C.A.E.S., with an additional grant from the National Science Foundation (NSF) to support the development of ancillary materials, student
and teacher guides. We were pleased with the warm reception of the film on its first showings to members of the M.I.T. community. Production on "Women's Work: Management," the second film in what is hoped will become a series, began with grants from the Sloan School of Management and the Aetna Life and Casualty Corporation.

The film unit is operated by Christine Dall, Head Film Unit, and Niti Salloway, Associate Producer, under the general direction of Mr. Fitch.

Research and Development

Telecommunications Project

During academic year 1974, the Sloan Foundation awarded C.A.E.S. a grant of $620,000 for the period October 1, 1975, through June 30, 1976. The grant was to establish a program of research and development in the use of broadband communication systems for higher education. The two major uses of the grant are toward the installation of a cable television system interconnecting the M.I.T. campus, and toward the development of faculty experience in the use of video in the production of software for use on the cable system. The design of the system has been completed with a fall, 1975, target for installation. The design and installation of the system are under the direction of John Ward of the staff of the Electronic Systems Laboratory, and Mr. Paton of C.A.E.S. Funds have been allocated to faculty members in nine departments or libraries of the Institute for the development of uses for video in instruction. Training in the use of film and video media is under the direction of Professor Richard Leacock of the Department of Architecture and Mr. Roberts of C.A.E.S. Overall management of the grant is under the direction of Mr. Roberts. A followup proposal to the Sloan Foundation is being prepared under the direction of Dr. Tribus.

Other Research and Development

During academic year 1974-75, funds were sought for new educational projects to be carried out next year. The NSF funded Professor Lawrence B. Evans of the Department of Chemical Engineering and Dr. Tribus for a "Model Program in Continuing Education in Chemical Engineering" which will provide for the analysis of the chemical engineering curriculum and production of a large series of instructional modules on videotape.

The Sloan Foundation awarded funds to Professor Ithiel Pool of the Department of Political Science for the development during summer, 1975, of a "Continuing Education Program in Communications for the FCC," to be administered by C.A.E.S.

The Social Services Agency of Iran funded Professor Merton Flemings of the Department of Materials Science and Engineering, for the research and development at M.I.T. of innovations in technical education and training related to the development of a program which will aid secondary schools and industry in expanding career opportunities for women in technology and science.

Student Support

Although the Center does not enroll undergraduates in accredited subjects, there are several activities primarily involving undergraduates. As mentioned above, C.A.E.S. subsidizes
the teaching of several departments through the use of its video facilities. The Center also provides office space and professional advice to MITV, a student extracurricular group which produces and displays a weekly television news program for the M.I.T. community. The Center supported an I.A.P. project, organized by Professor Leacock and the Hayden Gallery, with equipment and personnel. In addition, an I.A.P. subject was developed by and taught by Mr. Paton on television technology, and several UROP projects are sponsored by the Center, one with Mr. Roberts concerning the application of microcinematography to video, and another by Mr. Paton on the design and maintenance of video equipment. Mr. Christiansen is active in freshman counseling, and Mr. Collias serves the admissions procedure in the reading and adjudicating of applicants to the undergraduate program.

MYRON TRIBUS

Center for Policy Alternatives

The third year of the Center for Policy Alternatives has been one of growth in research and personnel, of increasing interaction with the educational and research activities of M.I.T.'s departments, centers, and laboratories, and of continuing service to the Institute as a whole. Among the Center's primary functions are the identification of major sociotechnical issues facing society, the assessment of the consequences of present policies and practices, and the development and appraisal of alternative actions which will respond effectively to society's needs. The Center studies and investigates substantive issues in a wide spectrum of pressing societal problems in government, industry, and education, particularly those in which technology and engineering could play significant roles. A clear indication of the need for, and the place of, this kind of research at M.I.T. is the increase over the last two years in sponsored research administered by the Center, from $300,000 in fiscal 1973 to more than $1.2 million in fiscal year 1975.

In carrying out its sponsored and ongoing research programs, the Center serves as a focal point for many of the policy oriented activities of M.I.T. departments, centers, and laboratories, and seeks to stimulate faculty and students to participate in projects which have the greatest potential for social and economic utility. The number of faculty members partially supported by Center projects increased from seven in fiscal year 1973 to 14 in fiscal year 1975, with a corresponding increase in student support from 11 to 36 graduate students. Because the Center has no formal teaching program, the faculty and students it supports are drawn from M.I.T.'s departments, and these increases reflect in part the growing impact of the Center on the educational and research programs of the Institute.

Research Activities

The Center's sponsored and developmental research activities during the past fiscal year can be summarized in seven broad program areas: technology policy and innovation; manpower policy; consumer related studies; industrial productivity policy; environmental and workplace regulation; communications and the public interest; and natural resources and energy.
The Technology Policy and Innovation Program included five sponsored projects as well as continuing developmental research. One aspect of this program seeks to examine national policies influencing innovation and technical change within various nations, to formulate alternative policies specific to each national environment, and to translate foreign experience to U.S. policy. The second, and complementary, research interest focuses on understanding the processes of innovation and technical change within the firm, and the private practices and public policies that influence these processes at the level of the firm.

The Center's first project to examine the issues of government policy and technology, and the first to be sponsored by a foreign government, was completed this year. Funded by the General Delegation for Scientific and Technical Research (DGRST) of the French government, this two-year project focused on selected policy instruments and practices aimed at supporting effective technology utilization in French industry. Representatives of DGRST were briefed on the major conclusions of the study in summer, 1974, and the final report was submitted in spring, 1975. Participants during the past year included Dr. J. Herbert Hollomon, Director of the Center; Dr. Marvin A. Sirbu, Dr. James M. Utterback, and George R. Heaton, Research Associates; and three graduate students.

The completion of the Sahel-Sudano project in January, 1975, is a contribution to the future economic development of six drought-stricken African nations. Funded by an 18-month, $1 million contract from the Agency for International Development (AID), this effort examined the multiple impacts of various economic development strategies on the countries in the sub-Saharan zone of Africa in terms of population, standard of living, health, education, and social traditions. Perhaps as important as the research findings, the 12-volume final report is the first integrated appraisal of the complex geographical, economic, and social factors which must be considered by the African countries and international organizations if these nations are to improve their standards of living. The project was directed by Professor William W. Seifert of the Department of Civil Engineering, principal investigator, and Dr. Nake M. Kamrany, Research Associate and project manager. Project participants included Professors David C. Major, Paul O. Roberts, and Research Associate Joseph E. Soussou of the Department of Civil Engineering; Professor John B. Stanbury of the Department of Nutrition and Food Science; Dr. K. Nagaraja Rao, Senior Research Associate; Dr. Hani K. Findakly and Dr. Lois H. Godiksen, Research Associates; and seven graduate students.

As fiscal year 1975 came to a close, the Center's five-country technology policy project was nearing completion after two years of research. Supported by a National Science Foundation grant, and funds from the Alfred P. Sloan Foundation, this project examined and evaluated the consequences of various government policy instruments on technological change in France, the Netherlands, Japan, the United Kingdom, and West Germany. A bibliography on science and technology policy with more than 600 entries, many of which are abstracted, was published in May, 1975. The project's findings suggest new directions for U.S. policy which will be examined during the coming year. A final report and a monograph on each country are being prepared under the direction of Dr. Nicholas A. Ashford, Senior Research Associate, and are scheduled for publication in September, 1975. This research effort involved nine students, Professor Thomas J. Allen of the Sloan School of Management, Professor Arthur Gerstenfeld of Boston University, Dr. Alexander Houtzeel of the Organization for Applied Industrial Research of the Netherlands, Dr. Christopher Harlow of the Political and Economic Planning Foundation in London, and eight staff members of the Center.

Substantial progress was made throughout the year on the collaborative research project with the State Council on Technology (CET) of Sao Paulo, Brazil, under the direction of Dr. Rao. Funded by CET, the two-year project is examining present government programs promoting existing and new technologies for economic development and then will develop alternative
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programs for the unique Sao Paulo environment. Research tasks include sector analyses of the food processing, electronic, metallurgical, and machine-tool industries; analytical studies of innovations based on a sample of over 200 Sao Paulo firms; and engineering studies of specific technologies in selected firms. Research Associate Byron F. Battle is directing the Brazilian research team in Sao Paulo which includes Shing Fung, a graduate student in the Sloan School of Management, and 15 Brazilian nationals. Dr. Rao's Cambridge research team includes Professor Richard D. Robinson of the Sloan School of Management, four graduate students, and four staff members of the Center.

Research activities concerned with the processes of innovation and technical change at the firm level are being coordinated by Dr. Utterback who is also a Visiting Associate Professor at Harvard University Graduate School of Business Administration. Dr. Utterback and Professor William J. Abernathy of the Harvard Business School are continuing their development of a dynamic model of process and product innovation by firms. This work, a new framework for studying innovation, is currently focusing on the relationships among the capability of a firm to innovate, its competitive strategy, and the stages of development of its production process.

In January, 1975, the Center undertook an 18-month study to determine the economic impact of the National Sea Grant Program on U.S. industries and foreign trade. Funded by the National Oceanographic and Atmospheric Administration, the project includes examining the possible economic consequences of selected Sea Grant projects at various institutions and an analysis of the seven major economic sectors potentially affected by Sea Grant activities. The project is being directed by Dr. Utterback and includes Professors Judith T. Kildow and Henry S. Marcus of the Department of Ocean Engineering, Dr. Sam Pasternack, Research Associate, two M.I.T. graduate students, and two graduate students from other schools.

Manpower Policy

The Center's Manpower Policy Program became an established research area during 1974-75. Work is well under way on a two-year project funded by the government of Venezuela to study high-level manpower availability and utilization in Venezuela. Under the direction of Dr. Rao, the project is analyzing the supply and demand phenomena for professional and technical workers in the public and private sectors in order to provide policy guidelines for a very large manpower project undertaken by the Gran Mariscal Ayacucho scholarship program in Venezuela's national planning agency, CORDIPLAN. Sheldon Friedman, Research Staff, and Professor Richard B. Freeman of Harvard University are working with Dr. Rao in Cambridge; Clementina Gomez de Petit is coordinating the research team of Venezuelan students in Caracas, Venezuela.

With the support of Alfred P. Sloan Foundation funds, research continued on modeling and analyzing the supply and demand relationships of professional and technical manpower in the United States. Throughout much of the year, Postdoctoral Fellow Dr. Baruch Raz, Dr. Sirbu, Mr. Friedman, and Research Fellow Robert Treitel updated the engineering model previously developed in the Center to incorporate the recent economic downturn and to examine the demand for particular types of engineers. This ongoing research, as well as the publication this past winter by the American Society for Engineering Education of the Center's engineering education study, has had a significant impact on the School of Engineering and its departments.

The importance of this type of research to industry, government, and educational institutions was brought out at a recent one-day symposium jointly sponsored by the Center and the Industrial Liaison Office and attended by 200 people. Entitled "Professional Manpower: Problems Ahead?" the symposium featured speakers from education, government, professional societies, industry, and labor discussing the changing markets for college graduates and the impact of declining enrollments on institutions and individuals. Several of the papers presented are expected to be published in the coming year.
Two developmental activities of the Manpower Policy Program were directed by Robert T. Lund, Senior Research Associate. A preliminary examination of licensure for various professions and occupations conducted during spring, 1975, established a working relationship with the Massachusetts Consumers' Council and helped to identify future research alternatives. Mr. Lund also developed the inverse seniority concept as an alternative personnel policy for the conflict between Equal Employment Opportunity programs and seniority experienced during economic downturns. This work was supported by the Center's Sloan funds and involved Mr. Friedman and a graduate student. An article discussing this promising concept and identifying the needed research is scheduled for publication in fall, 1975.

Consumer Related Studies

Activities in the Center's Consumer Related Studies Program are an outgrowth of the Center's highly successful consumer durables project jointly carried out with the Charles Stark Draper Laboratory during fiscal year 1974. The warranties, service contracts, and alternatives project, funded by NSF, is examining the various instruments for protecting the consumer from the economic consequences of product failure. Directed by Mr. Lund, the project involves Dr. Robert W. Crandall, Research Associate, and Mr. Heaton; Professor Warren H. Hausman of the University of Rochester; Professor Leon Courville of Ecole des Hautes Etudes Commerciales in Montreal; Professor Warren G. Briggs of Bentley College; Dr. J. Barton DeWolf and John Prohaska of the Draper Laboratory; and several graduate students. A preliminary investigation of the application of life cycle cost concepts to automobiles was begun by Mr. Lund and supported by the Center's Sloan funds. Participants included Drs. Utterback, DeWolf, and Crandall, Professor Briggs, Professor Eugene Rochlin of the University of California at Berkeley, and a graduate student. The consumer related studies program also involved the Center in advisory activities with the Federal Trade Commission, the U.S. Senate's Commerce Committee, and the National Academy of Science.

Industrial Productivity Policy

The multiple activities of the Industrial Productivity Policy Program are concerned not only with identifying the opportunities for new technologies in industry, but also with the social and economic aspects of manufacturing. Mr. Lund continued his involvement with Professor Nam Suh of the Department of Mechanical Engineering in the M.I.T.-Industry Polymer Processing Program. With the assistance of an undergraduate and graduate student, Mr. Lund is examining the process of establishing this particular innovative program at M.I.T. and the options for future programs of this type. Mr. Lund also continued his developmental effort to organize a research activity among industrial firms, government, and educational institutions, which would critically examine computer-managed manufacturing systems and their impact on the manufacturing process. In April, 1975, Dr. Kamrany began a preliminary investigation of the social and economic aspects of the discrete parts manufacturing industry in the U.S. This research is part of a larger Draper Laboratory project funded by NSF to explore the role of the Federal government in, and to delineate the research areas for, improving the productivity of discrete parts manufacturing firms.

Environmental and Workplace Regulation

Two research efforts in the Center's Environmental and Workplace Regulation Program were well established at the end of the fiscal year. Dr. Ashford is directing a one-year study of the impact of Federal regulation on the production, use, and distribution of chemicals. Funded by the Council on Environmental Quality and the Environmental Protection Agency, the research includes selected case studies as well as the development of methodologies and techniques
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for examining the complex social, economic, and political factors involved. Project participants include Professor Francois M. M. Morel of the Department of Civil Engineering, Professor Lawrence B. Evans of the Department of Chemical Engineering, Professor Gerald N. Wogan of the Department of Nutrition and Food Science, five students from M.I.T., three students from other universities, and six staff members of the Center.

In April, Dr. Ashford, Mr. Heaton, and Research Associate Dr. Dale Hattis began an initial examination of the methodology and a preliminary analysis of the difficulties in arriving at appropriate regulatory decisions on occupational noise. With support from the Center's Sloan funds, Dr. Ashford also undertook an initial examination of the role of collective bargaining and worker participation in improving occupational health and safety practices.

Communications and the Public Interest

Activities of the Center's Communications and the Public Interest Program expanded modestly during the past year. In January, 1975, the telecommunications policy project funded by NSF and directed by Professor Ithiel de S. Pool of the Department of Political Science was completed. The 18-month project examined telecommunications policy activities in government and industry and identified the critical issues in telecommunications policy that would benefit from additional research. An important aspect of this effort was an analysis of the economic value and allocation strategies of the land-mobile radio spectrum which Dr. Crandall coordinated. Project participants during the year included Research Associate Dr. Dudley Coillet; Dr. Lawrence McCray, Research Associate in the Center for International Studies; and three graduate students. The second research activity completed during the year was Dr. Crandall's economic examination of the prospects for pay television broadcasts of live cultural events from the Lincoln Center for the Performing Arts. This activity was funded by Lincoln Center through the Electronic Systems Laboratory.

One outgrowth of the telecommunications policy project is the multisponsored Datanet project which began during fall, 1974. Directed by Professor Pool and funded by the U.S. Departments of State and Commerce, AID, and the National Aeronautic and Space Administration, the overall effort is examining specific issues in the design, organization, and use of international data communication and information retrieval systems, particularly the political and social impacts of these low cost, distance-insensitive communication systems. This project supported four graduate students and is being coordinated by Arthur B. Corte, Research Staff, who is on leave from the Department of State.

Natural Resources and Energy

Center activities focusing on natural resources and energy policies continued at a modest level, largely with the support of Sloan funds. Following the publication of their updated economic analysis of breeder reactors in July, 1974, Research Associate Dr. Jean-Claude Derian, and Dr. Irvin C. Bupp of the Harvard Business School examined the economics of commercial nuclear power, particularly the trends in light water reactor capital costs. The results of this study were published in February, 1975, and identified the particular uncertainties which make the economic advantages of light water reactors indeterminate. Later in the year, Professor Hollomon, Dr. Raz, and Mr. Treitel completed a preliminary study of nuclear power and oil imports from the viewpoint of a net energy balance. The Center's examination of the institutional factors influencing the nation's energy research and development effort, which was completed in fiscal year 1974, was published in spring, 1975.

In fall, 1974, the final report of the coastal zone project was submitted to the National Oceanic and Atmospheric Administration. Directed by Dr. Hollomon and Professor Kildow, this
Center for Policy Alternatives

The Center for Policy Alternatives project developed criteria for reviewing state level programs and decision processes relating to coastal zone management. During winter, 1974, Professor John W. Devanney of the Department of Ocean Engineering carried out a preliminary examination of the requirements and rationale underlying the management of domestic continental fisheries under a 200-mile limit. This work was supported in part by Sloan funds and by M.I.T. Sea Grant funds.

In the second term of the academic year, the Center and the Department of Materials Science and Engineering jointly sponsored a seminar series, coordinated by Dr. Hollomon and Professor Michael B. Bever of the Department of Materials Science and Engineering, which brought experts from science, engineering, economics, government, and industry to focus on the issues and non-issues of the nation's materials policy. As the fiscal year came to a close, Drs. Ashford and Hattis, Dr. Albert E. Murray, Research Staff, and a graduate student, began an examination of the potential industrial applications of chitin and chitin derivatives under the sponsorship of the M.I.T. Sea Grant Program.

**Educational Activities**

As part of the School of Engineering, the Center has a continuing interest and concern in public and private policies which influence the education and career development of engineers in the United States and throughout the world. This commitment is reflected not only by the Center's ongoing research activities in professional and technical manpower already noted, but also by the direct participation of Center staff in teaching and developing new educational programs.

Supported by an Alfred P. Sloan Foundation grant to the School of Engineering, Drs. Hollomon and Sirbu joined a large number of faculty from throughout the Institute to develop a new Master's degree program for engineers. This new degree was approved by the faculty in April, 1975, and the pilot program is scheduled to begin in September, 1975. The program, leading to a Master's degree in Technology and Policy, is an intensive graduate program for students who wish to study economics, social science, and systems analysis at the same time that they are taking a concentration of subjects in one of the engineering disciplines.

During the second term of 1974-75, Mr. Lund, also a Lecturer in the Department of Mechanical Engineering, and Professor David P. Hoult of the Department of Mechanical Engineering introduced their newly designed subject, 2.96J Management in Engineering. The subject offering was highly successful. Mr. Lund's other subject offering, 2.863 Elements of Manufacturing, was canceled due to limited enrollment. Both subjects will be offered in 1975-76.

In addition to teaching, Mr. Lund chaired a study group for the School of Engineering that examined the educational and research opportunities related to manufacturing. This study considered degree programs, concentration programs within existing disciplinary degrees, and the coordination of manufacturing research activities within the School. The findings have been presented to the Engineering Council and the Dean. Participants included Robert Carlson, Western Electric Company; Professors Stanley Backer and Nathan H. Cook of the Department of Mechanical Engineering; Professor Benjamin L. Averbach of the Department of Materials Science and Engineering; Professor John F. McCarthy of the Department of Aeronautics and Astronautics; Professor Roberts of the Center for Transportation Studies; Professor Arnold C. Hax and Lecturer John F. Rockart of the Sloan School of Management; Professor Patrick H. Winston of the Department of Electrical Engineering and Computer Science; and Dr. David Gossard, who was appointed Assistant Professor of Mechanical Engineering in spring, 1975.
Throughout the past year, staff members of the Center have contributed to academic subject offerings in various departments. For example, Dr. Rao, also Senior Lecturer in the Division for Study and Research in Education, participated in the research activities, seminars, and educational programs of the Division.

J. HERBERT HOLLOMON

Center for Transportation Studies

This year, 1974-75, has been particularly successful for the Center for Transportation Studies (C.T.S.). The volume of research funded through the Center has increased more than 400 percent; two major interdisciplinary research proposals to the U.S. Department of Transportation's University Research Program have won support in competition with 12 other universities; the Center has begun work on its development plan; and, in conjunction with the Legal Studies Program, a major grant has been received from the Union Pacific Foundation.

Professor Paul O. Roberts of the Department of Civil Engineering continued as Director of the Center this past year. The Steering Committee consists of Professor Roberts and eight other members, as follows: Professor Alan Altshuler, Departments of Political Science and Urban Studies and Planning; Professor Ernst G. Frankel, Department of Ocean Engineering; Professor Ralph A. Gakenheimer, Department of Urban Studies and Planning, representing the School of Architecture and Planning; Professor Peter Lorange, Sloan School of Management; Professor Herbert H. Richardson, Department of Mechanical Engineering; Professor Joseph M. Sussman, Department of Civil Engineering; Professor William C. Wheaton, Departments of Economics and Urban Studies and Planning, representing the School of Humanities and Social Sciences; and Professor Robert W. Simpson, Department of Aeronautics and Astronautics.

One full-time Research Associate, Elizabeth Bennett, has joined the staff. Dr. Frank C. Colcord, Jr. of Tufts University and Dr. Daryl Wyckoff of the Harvard Business School have continued their appointments as Research Affiliates. Another Research Affiliate, John Lawson, has been added this year. The Center also employs consultants from time to time in connection with its research projects. This year Charles Manski, of Carnegie Mellon; Antii Talvitie, of the University of Oklahoma; Frank Koppelman, of Northwestern University; and James Kneafsey of Cambridge served in this capacity. More than 25 students were associated with Center-related research projects during the year. The Center's offices are in Building 5-204 and 5-206.

Newsletter

The Newsletter continues to be well received and widely read. Rebecca Muller, secretary in the Center, has edited outstanding newsletters this year. The newsletters report recent contracts, seminars and workshops, and other transportation news at the Institute.
Brochure

The Center is in the final stages of preparing a brochure describing the Center and its activities. A brochure prepared last year continues to generate inquiries. This one-page poster briefly described the opportunities for graduate transportation studies at M.I.T. with a tear-off card at the bottom for those interested in further information. This year's brochure explains what the Center is and what it does. The brochure will mention the Center's academic program, research program, and communication and coordination program.

Publications

There are now six published reports in the C.T.S. Report series for 1975. They are as follows:


In addition to these six reports, the Center has now assembled copies of a large number of recent publications in Building 7-015 where a list is almost completed and will be issued later in 1975.

Luncheon/Seminar Series

Another successful luncheon seminar series was sponsored this year by the Center. The same format was followed as in past years -- an informal buffet luncheon every Friday from noon until 12:45 PM, followed by an informal talk from an invited speaker on a timely policy issue. In all, there were ten guest speakers during the fall and spring terms. The speakers included the new Secretary of Transportation and Construction for Massachusetts, Fred Salvucci, who talked on "Transportation and Politics: The Boston Scene." Robert Thompson, counsel to the
Boston Regional Environmental Protection Agency, spoke on "Post-Hearing Revisions to the Boston Air Quality Control Strategy." George Scelzo from Personal Rapid Transit Systems Corporation in Chicago discussed "Astroglide, the Slim Transit System." Professor Ann F. Friedlaender, newly appointed Professor in the Departments of Civil Engineering and Economics, talked about "Regional Macroeconomic Modeling in Massachusetts." John C. Emery, Jr., President of Emery Air Freight Corporation spoke on "Air Freight in the 1970s." Charles Foreman, Vice President and Director of United Parcel Service highlighted "Transportation Policy and Small Package Movement." The Center plans to continue this program again in fall, 1975.

Research Program

During the year, some 30 proposals were submitted under the auspices of the Center. Of these, 16 were successful and received funding. Their contract value totals more than $3.2 million. Current research projects are outlined in the following table.

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<tr>
<th>Title</th>
<th>Sponsor</th>
<th>Project Supervisor</th>
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<tbody>
<tr>
<td>Research in Transportation Planning</td>
<td>U.S. Department of State; AID</td>
<td>F. Moavenzadeh</td>
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<tr>
<td>Develop Urban Transportation Guidelines</td>
<td>U.S. Department of Transportation (DOT); Transportation Systems Center (TSC)</td>
<td>M. Manheim</td>
</tr>
<tr>
<td>Improve the Integration of Air Quality Considerations into Transportation Decision-Making</td>
<td>Environmental Protection Agency (EPA)</td>
<td>M. Manheim</td>
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<tr>
<td>Urban Travel Forecasting Research</td>
<td>U.S. DOT</td>
<td>M. Manheim</td>
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<tr>
<td>Dial-A-Ride Computer Control System</td>
<td>First Date Corporation</td>
<td>D. Roos</td>
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<tr>
<td>Dial-A-Ride Bus System</td>
<td>U.S. DOT/TSC</td>
<td>D. Roos</td>
</tr>
<tr>
<td>Integrated Adaptable Metropolitan Service Program</td>
<td>Regional Transit Service, Inc.</td>
<td>P. Roberts</td>
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<tr>
<td>Development of an Aggregate Model of Urbanized Area Travel Behavior</td>
<td>U.S. DOT</td>
<td>P. Roberts</td>
</tr>
<tr>
<td>Intercity Data Analysis</td>
<td>U.S. DOT/TSC</td>
<td>P. Roberts</td>
</tr>
<tr>
<td>Railroad Line Abandonment in New England Towns: A Study of Impacts and Alternatives</td>
<td>Union Pacific Foundation</td>
<td>J. Vittek</td>
</tr>
<tr>
<td>Analysis of the Incremental Cost and Trade-Offs between Energy Efficiency and Physical Distribution Effectiveness in Intercity Freight Markets</td>
<td>Federal Energy Administration (FEA)</td>
<td>P. Roberts</td>
</tr>
<tr>
<td>Analysis of Freight Markets</td>
<td>U.S. DOT</td>
<td>P. Roberts/H. Marcus</td>
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<tr>
<td>Reliability and Car Utilization</td>
<td>Association of American Railroads</td>
<td>J. Sussman</td>
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Decisions are still pending regarding the following four proposals, amounting to more than $600,000.

- Improving Seaport and Airport Facilities in the Coastal Zone
  - Sponsor: U.S. DOT/University Research Program
  - Project Supervisor: H. Marcus

  - Sponsor: National Science Foundation (NSF), Research Applied to National Needs (RANN)
  - Project Supervisor: P. Roberts

- Transportation Network Analysis and Decomposition Techniques
  - Sponsor: U.S. DOT/TSC
  - Project Supervisor: R. Simpson

- Study of Future Transportation Developments
  - Sponsor: U.S. DOT/TSC
  - Project Supervisor: J. Vittek

**Academic Program**

The Center does not have an individual academic program. It does, however, coordinate transportation subjects throughout the Institute. Requirements for a new degree, Transportation Engineer, have been drafted and are now being circulated for comment and review.

**Summer Session Offerings**

During summer, 1975, there will be four subjects offered in transportation at the Institute. They are:

1) Air Transportation Systems Analysis, Parts 1 and 2. This program will be presented by the faculty and staff of the Flight Transportation Laboratory, Department of Aeronautics and Astronautics.

2) Analysis of Urban Service Systems. The program will be under the direction of Professor Richard C. Larson of the Department of Urban Studies and Planning. There will be three other guest lecturers complementing Professor Larson.
3) Analysis and Design of Transportation Systems, Parts 1 and 2. This program is to be directed by Professor Manheim, assisted by M.I.T. faculty from the Departments of Civil Engineering, Ocean Engineering, and Aeronautics and Astronautics.

4) Decision Making under Uncertainty: Methods and Applications of Decision Analysis. This program will be directed and presented by Professor Alvin W. Drake of the M.I.T. Operations Research Center and the Department of Electrical Engineering and Computer Science, and Dr. R. L. Keeney, who was once Associate Professor of Operations Research and Management at M.I.T., and is currently a research scholar at the International Institute for Applied Systems Analysis, Laxenburg, Austria.

Development Plan

The development plan of the Center has been approved by the M.I.T. administration. Work to gain support for the plan has been initiated. Professors Roberts, Sussman, and Simpson have made development calls on a number of industry leaders and alumni to obtain their advice and support. Copies of the Development Plan are available from the Center's offices.

PAUL O. ROBERTS

Innovation Center

As of June, 1975, the Innovation Center, supported by the National Science Foundation (NSF) concluded its second year in a five-year experiment. Students are introduced to the program primarily through two branches of instruction: invention and entrepreneurship. Under the guidance of a group of faculty organized as the Innovation Education Council (I.E.C.), students may enroll in several subjects including both classroom lectures and laboratory operation. Students are encouraged to develop laboratory models of inventions of their own, or of inventions of others. At this point, M.I.T. makes no claim of any equity derived from student innovative activities. Any student developments with commercial potential can be introduced to the Innovation Co-op by submitting a business plan to the Co-op's Advisory Board. Successful projects are then commercialized through licensing or through the establishment of a new venture. M.I.T.'s share of the income from commercialization of the products will be retained by the Center for future operation.

Overall, this year has been a fruitful one. Eleven of the projects already have approached the stage of commercialization. The faculty members participating in the I.E.C. met once a week regularly. Their function included teaching, designing new subjects, evaluating student proposals for possible NSF support, conducting the student innovation contest, evaluating outside inventions, preparing operating methodologies, and developing relationships with industry.

The Advisory Board met once every three months and provided valuable guidance to the operation of the Co-op. In addition to the approval of the initial funding of each project, the Board reviewed the progress and made recommendations at significant turning points of each project.

With the support of the Industrial Liaison Program, an Innovation Center symposium was organized last February. This, together with the front-page article on the Center in the
January 22, 1975 issue of the Wall Street Journal, opened the door for serious negotiations with Sears, Roebuck and Company, AMF, and other industrial firms for possible ties between these companies and the Center.

While conducting the experiment on the clinical phase of innovation education, attempts were made to examine the methodology in teaching innovation. A collection of papers which illustrate some of the innovative approaches has been compiled. This material may lead to the publication of a book on teaching innovation.

Y. T. Li
This year was a busy one for the School because of three developments: 1) the introduction of the new Institute Requirement in the Humanities, Arts, and Social Sciences; 2) the beginnings of a thorough review of personnel policies; and 3) the development of new projects designed to link the Humanities and Social Sciences more closely with Engineering and Science.

There were also an unusually large number of changes in the headships of the departments. Professor Myron Weiner succeeded Professor Eugene B. Skolnikoff as Head of the Department of Political Science. He has been a member of the Department for 14 years and is well known for his work on the politics of India. Professor Bruce Mazlish became Head of the Department of Humanities in place of Dean Harold J. Hanham who had been Acting Head for 17 months. Professor Mazlish first came to the Institute in 1950 and his taking office coincided with the publication of his important book on James and John Stuart Mill. For the spring term, Professor Sylvain Bromberger also served as Acting Head of the Department of Philosophy while Professor Richard Cartwright was on research leave.

The new Institute Requirement approved by the faculty in spring, 1974, was undoubtedly a success, judged by student reactions. Students welcomed the opportunity to devise plans of study appropriate to their individual interests and needs, enjoying particularly the greater range of choice open to them in the freshman and sophomore years. Thanks to careful planning by Dean Donald L. Blackmer and the Registrar, there were unusually few administrative snags, so that for most students the transition from the old to the new Requirement was a smooth one.

Within the School of Humanities and Social Science the chief impact of the new Requirement was felt in the area of curriculum planning. Professor Robert E. Jones of the Department of Foreign Literature and Linguistics chaired a special committee assigned by the faculty to evaluate subjects for inclusion in the list of Distribution subjects, recognize Fields of Concentration, and oversee the administration of the Requirement generally. Departments were invited to suggest Distribution subjects and Concentrations and to discuss them with the committee. This led to some reexamination of their offerings by departments and to a number of important debates about the educational purpose of the Requirement, some of which are not yet finally resolved.

Whether the new Requirement is likely to make a substantial difference in the overall pattern of enrollments in the School cannot be reliably estimated for two or three years. This year's freshmen, no longer required to choose a single year-long sequence from a limited list of subjects, have distributed themselves more widely around the Institute than ever before. About twice as many freshmen registered in elementary economics subjects this year as last, contributing to the general upward trend in economics enrollments occurring at M.I.T. and at other colleges as well. Contrary to national trends, on the other hand, is a rise in enrollments in foreign languages and literatures, notably in French and Spanish; this increase should certainly be attributed in substantial part to the change in the Requirement, which had previously acted as a deterrent to student interest in these subjects. Music, previously not available to most freshmen except as an extra elective, was also a substantial gainer. These and other enrollment increases were balanced off by declines in some of the fields which had previously been strongly represented in the freshman core curriculum, especially the subjects in
philosophy and in the Western tradition. It will be some time before longer term trends become clear, because undergraduates are now free to take their three Distribution subjects at any time during their stay at M.I.T., and many of this year's freshmen are not yet sure how far they wish to go in the fields of study they have taken as freshmen. But it is reasonable to expect some fluctuations in enrollments in individual departments until several classes have had a chance to come to grips with the new Requirement.

One thing which must be done in the immediate future is to increase the range of offerings in certain areas, notably history, Spanish, and sociology, where there is not at the moment a satisfactory mesh between subjects offered and student interest.

The four tables that follow this report give detailed information on student enrollment for this and previous academic years.

Discussions of personnel matters consumed much of the time of the School Council this year. Too little attention has been paid in the past in some departments to career planning for junior faculty and other members of the teaching staff. This has been recognized as a problem for more than a decade, but only lately, in an era of tight budgets and a new pattern of undergraduate teaching, has it seemed possible to bring about needed changes. The policy adopted by the School Council is: 1) that all the departments of the School should, save in very unusual circumstances, make appointments only to the faculty ranks rather than as Lecturers or Instructors; 2) that every member of the teaching staff not holding a tenured appointment should be subject to regular review and evaluation within his or her department and that the result of that review should be communicated to the School Council for further consideration; 3) that reappointments and non-tenure promotions should not be virtually automatic, as has been the case to some extent in certain departments; 4) that new appointments should be reserved for those who can demonstrate the highest professional achievement appropriate to the rank involved; and 5) that Assistant Professors in fields where the Ph.D. is the normal basic professional qualification should possess that degree.

The School has a special responsibility for the development of programs that serve to link the Humanities, Arts, and Social Sciences on the one hand with Science and Engineering on the other. Discussions in the past two years have chiefly concerned two areas, the development of a body of faculty members at M.I.T. whose interests bridge the gap between the "two cultures," and cooperation between the School of Humanities and Social Sciences and the School of Engineering.

During the 1973-74 academic year, two types of faculty recruitment were investigated. First, a group of faculty already at M.I.T. were brought together in seminars and other discussions by Professor Nathan Sivin of the Department of Humanities. This led to the development of an experimental program in the School called Technology Studies. In fall, 1974, Professor Louis L. Bucciarelli, Jr. returned to M.I.T. to become director of the program and also joint director of Course XXI. Three new faculty members also joined Technology Studies, as noted in more detail in the following pages. Secondly, a committee was established under the chairmanship of Professor Elting E. Morison to make recommendations for appointments to a number of vacant chairs, which might appropriately be held by those with a humanistic background and a special interest in science or engineering. This committee will continue to meet in the 1974-75 academic year. It is hoped that several new appointments, reinforcing those in Technology Studies, will result in M.I.T.'s becoming a major center for thinking about the problems of a technological society.

Relations with the School of Engineering have been fostered by cooperation in the development of a new Master's degree program in Technology and Social Systems in the School of Engineering and by a program of postdoctoral fellowships awarded jointly by the two Schools. These fellowships were made available to the Institute as part of a generous grant from the Andrew W.
Mellon Foundation to encourage joint activities by the two Schools and to develop the oral history of science and technology. A new oral history program became possible with the recruitment of Professor Charles Weiner, formerly director of the historical program of the American Institute of Physics. The array of activities now under way in oral history is discussed in the report on the Technology Studies Program.

HAROLD J. HANHAM
TABLE I

Enrollment in Distribution Subjects: 1974-75

<table>
<thead>
<tr>
<th>Field</th>
<th># of Subjects</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5 &amp; Graduate</th>
<th>Total</th>
<th>MIT</th>
<th>Wellesley</th>
<th>Harvard</th>
<th>TOTAL</th>
<th>%</th>
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</thead>
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<td>61</td>
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According to the new Institute Requirement in the Humanities, Arts, and Social Sciences introduced in 1974-75, every student must take a total of three Distribution subjects in three different fields before graduation. In the first year, only the Freshman class was fully subject to the new Requirement.

Enrollment data are taken from the Registrar’s fifth week report (Subject Distribution Report), corrected to remove subjects that were cancelled.
<table>
<thead>
<tr>
<th>Field</th>
<th># of Subjects</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5 &amp; Graduate</th>
<th>Total</th>
<th>MIT</th>
<th>Wellesley</th>
<th>Harvard</th>
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<th>%</th>
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<td>59</td>
<td>63</td>
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<td>67</td>
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<td>426</td>
<td>432</td>
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<td>76</td>
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<td>16</td>
<td>82</td>
<td>3</td>
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<td>1</td>
<td>94</td>
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<td>75</td>
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</table>

TOTAL                   | 248          | 793    | 1604   | 1816   | 1549   | 249               | 6011  | 332 | 22        | 0       | 6365        | 99.8 |

%                                    | 12.4         | 25.2   | 28.5   | 24.3   | 3.9    | 94.3              | 5.2   | 0.3 | 99.8      |
### TABLE III

Undergraduate Majors in the School of Humanities and Social Science*

<table>
<thead>
<tr>
<th>Year</th>
<th>Economics</th>
<th>Humanities</th>
<th>Philosophy</th>
<th>Political Science</th>
<th>Total</th>
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<td>224</td>
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<td>121</td>
<td>--</td>
<td>73</td>
<td>270</td>
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<tr>
<td>1967-68</td>
<td>81</td>
<td>148</td>
<td>--</td>
<td>76</td>
<td>305</td>
</tr>
<tr>
<td>1968-69</td>
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<td>--</td>
<td>79</td>
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<tr>
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<td>85</td>
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<tr>
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<td>59</td>
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<tr>
<td>1971-72</td>
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<td>124</td>
<td>13</td>
<td>38</td>
<td>238</td>
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<td>10</td>
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### TABLE IV

Graduate Students in the School of Humanities and Social Science**

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<th>Political Science</th>
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<td>1968-69</td>
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<td>1969-70</td>
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<td>269</td>
<td>2,826</td>
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* As registered in the second term of academic year 1965-66 to 1974-75, omitting freshmen and undesignated sophomores.

** As registered in the second term of academic year 1965-66 to 1974-75, including special graduate students.
In the course of the academic year 1974-75, Technology Studies was transformed from a set of good intentions into an academic program. Faculty members, appointed in July, 1974, came together this January, and in addition to engaging in individual research projects, have been hard at work planning a first curriculum, preparing for its formal inception next fall, and carrying on a variety of consultations, seminars, and colloquia.

Research

Louis L. Bucciarelli, Associate Professor of Engineering and Technology Studies, is the Director of the program. Professor Bucciarelli, in collaboration with Dr. Nancy Z. Dworsky, a Lecturer in the Department of Humanities, currently is completing a historical study of early nineteenth century contributions to the theory of elasticity. The major focus of this work is on the role played by Sophie Germain, a mathematician who lived and worked in Paris, in the development of a theory explaining the behavior of elastic plates. Particular attention is paid to the social and political character of the scientific establishment of Napoleonic France as revealed through the correspondence of Mlle. Germain with members of that establishment, including Legendre, Poisson, Fourier, Navier, and Cauchy.

Professor Irving Kaplan of the Department of Nuclear Engineering continues research on the historical development of nuclear engineering. Another, not unrelated project, involves the study of the history of atomic theory and other theories of the constitution and properties of matter.

Kenneth R. Manning, Assistant Professor of the History of Science, is doing research on the history of mathematics. He is working specifically on a history of functions of a complex variable and also on the concept of rigor in the development of mathematics. Another project concerns the history of blacks in American science and technology. Professor Manning is presently working on biographies of black mathematicians who lived during the early part of this century.

Nathan Sivin, Professor of the History of Science and of Chinese Culture in the Department of Humanities, is studying scientific thought in traditional China, including its social relations and anthropology. Chinese response to Western science is an integral part of this research. A recent line of investigation, which incorporates methods of structural analysis learned from English social anthropologists, has aimed at untangling the social roots of Chinese medicine. The long-term goal of these investigations is to lay the foundations for a comparative history of science, which will be able to adduce cross-cultural evidence in answer to questions which are conventionally treated by reasoning a priori on the Western scientific experience alone.

Charles Weiner, Professor of the History of Science and Technology, is the coordinator and director of the Oral History Laboratory. He is engaged in several research projects,
including: a social history of the development of nuclear physics in various institutional and national environments in the 1930s and 1940s; a study of the emergence of safety guidelines for research on recombinant DNA (with Dr. Rae Goodell); a project involving the location, cataloging, and critical evaluation of the correspondence of Robert Oppenheimer and the conduct of oral history interviews with several of the principal correspondents (with Dr. Alice Kimball Smith).

The M.I. T. Oral History Laboratory provides resources for teaching and research by documenting the life histories of individual scientists and engineers, the development of institutional environments for research, and the interaction of science, technology, and society.

Assistant Professor of Political Science Langdon Winner's research concerns the forms of technology one can identify which pose a genuine alternative to the structures and patterns which dominate our age. He is engaged in analysis of proposals and projects within the context of a set of organizing themes: 1) division of labor, 2) hierarchy, 3) level of complexity, 4) scale or size of the technological enterprise, 5) energy and material resource requirements, and 6) modes of legitimating design and subsequent control.

Joel Yellin, Associate Professor of Social Science, has three ongoing research projects:

1) A study of the social and economic implications of the international spread of nuclear energy. Specific areas of investigation include comparisons of nuclear power programs in France and the United States, international trade in nuclear equipment and supplies, public acceptance of nuclear power, and the comparative economics of nuclear and fossil fuel systems. Professor Yellin's collaborators in this research are Professors Paul L. Joskow of the Department of Economics and Henry Jacoby of the Alfred P. Sloan School of Management.

2) A study of world demographic information involving mathematical modeling of the associated processes. Example: two-sex models of population growth and decay, predator-prey systems, models of genetic processes in natural selection. Professor Yellin's collaborator in this research is Institute Professor Paul A. Samuelson of the Department of Economics.

3) An analysis of urban economic processes as they relate to the distribution of population, the availability of transport, the distribution of family income, and the effects of social and racial prejudice on housing quality and location.

Academic Program

Since Technology Studies will begin its teaching program in academic year 1975-76, a major effort in spring, 1975, led to the formulation of curricular principles, the design of a group of subjects, and their passage through authorizing committees. We are now able to provide students with an introduction to most of the areas of inquiry with which we will be concerned, areas ranging over the historical, social, and political dimensions of science and engineering activity. The diversity of backgrounds and interest in the group is reflected in the variety of subjects to be offered next year: e.g., 21. 775 Emergence and Growth of New Research Fields: A Social History; 21. 78 Technology, Innovation, and Culture; 21. 782 The Role of Blacks in American Science and Technology; 21. 783J Value, Choice, and Risk in Modern Technology; 21. 784J Theories of Technological Society and Politics; 21. 792J Aesthetics in Science and Technology.
These subjects may be used to meet the Field of Concentration requirement in the Humanities, Arts, and Social Sciences (by special arrangement, pending evaluation as a field of concentration next year). Some of them have been offered before, and many are jointly listed with various M.I.T. departments. Three subjects, 21.77 Science from the Renaissance through the Enlightenment; 21.774 Chinese Science and Natural Philosophy; and 21.791J Science, Technology, and Ritual, may be used by undergraduates to satisfy the Distribution requirement.

The planning of these subjects required that we explore many issues connected with the potential roles of Technology Studies at M.I.T. Among these issues were styles of inquiry and teaching appropriate to a genuinely humanistic study of science and technology; the importance and use of a historical perspective in a program concerned with technology today; the depth of engagement in technical issues that is called for, and the patterns of collaboration needed, to deal with the state of the art in various fields; and strategies for exploring the influence of technological change not only upon society but on the individual imagination.

Seminars and Colloquia

One of the main issues in the development of Technology Studies has been finding ways for a small faculty to encourage, facilitate, and collaborate in the humanistic endeavors of a great many members of the M.I.T. faculty. This year we have met with faculty from all schools of the Institute in four series of meetings.

A discussion group concerned with teaching humanistic issues in science and technology met to consider the substance and style of a number of subjects currently offered. Participants in these discussions included Professors Stephan L. Chorover, Alvin W. Drake, Joseph Ferreira, Irving Kaplan, Judith T. Kildow, Jonathan A. King, Thomas B. Sheridan, and Joseph Weizenbaum. Despite the great range of subject matter, the series was held together by recurrent pedagogical themes, notably the characteristics of technical vision, the resolution of such issues as social responsibility into aspects that can be studied systematically and in depth, and various approaches to connecting humanistic studies with technical content.

A second series, similar to the Technology Studies Workshop of previous years, brought scholars to M.I.T. who led discussions of their research on aspects of values in science and technology. The speakers and topics included the following:

1) Robert Fox, School of Historical Studies, The Institute for Advanced Studies, "Science Policy in Restoration France, 1815-30."

2) Rae Goodell, Postdoctoral Fellow, School of Humanities and Social Science, M.I.T., "The Visible Scientists."

3) Joel Primack, The Rockefeller University, "Public Interest Science."

4) Daniel Serwer, Program in the History and Philosophy of Science, Princeton University, "International Environmental Regulation: Past and Prospects."

5) Frank J. Sulloway, Junior Fellow, Society of Fellows, Harvard University, "Family Constellations, Sibling Rivalry, and Scientific Revolutions: A Discussion of the Effect of Birth Order upon Revolutionary Temperament in Science."
6) Sherry Turkle, Department of Sociology and Psychology and Social Relations, Harvard University, "French Psychoanalysis: A Social Perspective."

The attention of the M.I.T. community at large was directed to current issues in molecular biology in two colloquia by David Baltimore, American Cancer Society Professor of Microbiology at M.I.T. He spoke about attempts to control the potential hazards of research in that field.

A fourth activity which involved regular intellectual interchange with faculty from the various schools was the continued operation of the Technology Studies Steering Committee. This group offers advice and counsel on the development of the program at regular intervals. More than half its membership changes every year, so that the committee has the benefits of both continuity and a fresh point of view, as well as an increasing number of colleagues who we can count upon to be informed about the program.

Members of the Technology Studies faculty also have been active outside M.I.T. in helping to create a more conducive environment for humanistic study of science and technology. To mention only a few examples, one of us has played a prominent part in meetings to organize a nationwide communications network between technology studies programs; another has been documenting the Asilomar Conference on research hazards in molecular biology and its aftermath; and a third sits on a committee which is recommending fundamental changes in the training of historians of science to encourage a broader conception of undergraduate teaching than has been the norm.

LOUIS L. BUCCIARELLI, JR.

Department of Economics

This year witnessed a substantial upsurge in enrollment in our subject offerings -- a 16 percent increase, when weighted by credit units, compared with the Institute total of two percent. Coupled with expanded interdisciplinary teaching and research, public service, and professional activities, heavier demands were placed on the faculty.

Undergraduate Program

A change in the Institute Requirement in the Humanities, Arts, and Social Sciences, effective for the first time this past year, opened up the freshman and sophomore years to the full range of subjects meeting the Requirement. As a consequence, enrollments in introductory economics rose more than 25 percent. Much of this increased enrollment may be temporary now that students can take these subjects earlier than before. However, an increased interest in the subjects is also evident. Nearly 650 students took the first term of introductory economics, nearly 400 took the second, and more than 600 enrollments in economics electives were from outside our Department.
Thorough reconsideration of the introductory subjects initiated last year has been completed. The new subjects, 14.001 and 14.002 Economic Principles I and II, reverse the previous macro-micro ordering by treating microeconomic analysis and problems in the first term. More is demanded of students through problem sets and more advanced textbooks, and a new set of current readings has been developed. This major revision has been carried out under the leadership of Professor Peter Temin.

One consequence of this revision is the modification of the Concentration Requirement in economics under the new Humanities and Social Science program. The standard track for economic concentrators will continue to be one full year of introductory economics followed by an economics elective, such as comparative economic systems, money and banking, public finance, or international trade. An alternative track will be based on microeconomics. The introductory microeconomics, 14.001 Economic Principles I, will be followed by 14.03 Applied Microeconomics, substantially revised by Professors Paul L. Joskow and William C. Wheaton last year, and a microeconomics elective, such as industrial organization, urban economics, economic analysis of law, or economics of pollution, will complete the sequence. It is hoped, shortly, to have a third track that involves labor relations and labor economics.

Undergraduate majors continue at about the same number as in the past; fewer degrees were awarded (20), and there was a larger sophomore class. The curriculum has remained essentially unchanged, with somewhat greater faculty effort given to research guidance.

Graduate Program

Applications for admission to the Ph. D. program continued to rise last year to more than 330. Applications from women have increased substantially more than from men during the last four years -- nearly doubling as compared with the 15 percent overall increase. Nevertheless, the entering class has been held to 30: foreign student representation will be down slightly to 30 percent; women students will represent 17 percent; and minority students ten percent. Although financial aid continues to be tight, half of the entering class will be supported on National Science Foundation Fellowships -- these 15 represent nearly half of the total awarded in economics nationally.

There were 17 Ph.D.s awarded this academic year, with 12 percent to women. The job market proved to be stronger than was initially expected. In sharp contrast to last year, but in conformity with the long-run average, 82 percent of those going onto the job market accepted teaching positions, 16 percent in colleges and 66 percent in universities. Two, or nine percent, went into government positions and two into research positions in academic institutions.

For the first time, the Graduate Economics Association held an election for the outstanding teacher in the Department. Professors Robert F. Engle and Stanley Fischer tied for the honor this year.

Research

While research on urban problems has continued to provide an important focus for the Department, the research effort mainly centered in the Energy Laboratory now absorbs a larger number of faculty. Professor Morris A. Adelman has for years devoted a major
part of his research activity to the study of the world oil market. Professor Joskow has produced many important studies of various aspects of the energy problem -- regulation of electric utilities, demand for energy, and, with others from outside the Department, a comparative study of nuclear energy in Western European countries. These two faculty members along with Professors Robert E. Hall and Jerry A. Hausman produced an important document last year that examined the policies and costs of energy self-sufficiency. This year they have prepared a major critique of a similar report by the Federal Energy Administration, and some members testified to Congressional Committees regarding it.

Research in the urban area has in the past centered on the development of an urban model of Boston under the guidance of Professors Jerome Rothenberg, John R. Harris, and Engle. This work will reach fruition at the end of this year when a final report will be prepared. Modeling the urban housing market under Professor Rothenberg's direction in the Joint Center for Urban Studies has resulted in several publications already and will continue beyond this period. Urban transportation continues to be an active area of research: Professor Wheaton has examined some methodological problems in determining benefits and priorities of urban transportation; Professor Rothenberg edited a book, Transport and the Urban Environment, and he will join forces with a large interdisciplinary group under Alan Altschuler, Lecturer in the Department of Political Sciences, to examine, for the U.S. Department of Transportation, various strategies for overcoming barriers to innovation in urban transportation; Professor Ann F. Friedlaender's interests lie in the regulatory aspects of transportation.

The international research interests of the Department are also broad. In addition to those already mentioned in the energy group, Professor Jagdish Bhagwati is directing a large project of several monographs on foreign trade regimes and economic development. He has edited a volume on Illegal Transactions in International Trade: Theory and Measurement, and is preparing a monograph on methods of dealing with the 'brain drain.' Professor Richard S. Eckaus has completed several studies of capital markets in Latin America, e.g., the commercial banking structure in Mexico. He is carrying out research on the international transfer of technology in connection with committee work for the National Academy of Sciences and an AID sponsored research project, and is organizing an M.I.T. workshop to examine the U.S. foreign aid programs. Professor Charles P. Kindleberger has written several papers on commercial policy and on multinational corporations. He has made historical studies primarily of nineteenth century European economies -- the rise of free trade, Germany's surpassing of Britain, origins of direct investment in France, and wrote The Formation of Financial Centers: A Study in Comparative Economics. Professors Evsey D. Domar and Martin L. Weitzman continued their research into the comparative operations of capitalist and socialist systems and the theory of planning -- the use of the price system versus rationing, implications of various methods of land ownership and development, and alternative incentive systems. Finally, Professor Michael J. Piore is working with an interdisciplinary team on a comparative study of the dual labor market in France under a grant from the Ford Foundation.

The labor market in the United States has been explored quantitatively by Professor Hall who is particularly interested in the macroeconomic effects of its functioning, the inflation process, for example, and the consequences for the labor market of such government policies as a negative income tax. Professor Fischer has been examining some macroeconomic aspects of indexation in an inflationary context, the theory of money, and macro rules for optimal control of nonlinear models such as the economy. Professor Robert M. Solow has, as part of his varied interests, explored the analytic foundations of fiscal and monetary policy.

What may be termed "public microeconomics" has a variety of components. Professor Solow continues his work on the theory of renewable and nonrenewable resource use;
Professor Rothenberg edited a book on Management of Water Quality and the Environment; Professor Peter A. Diamond has continued his work on an economic analysis of law in the areas of accident law, the theory of risk and uncertainty, and social security financing (an area in which he has also served as advisor to the U.S. Senate Committee on Finance). Professor Friedlaender is directing a major project to develop an econometric model of the fiscal structure of Massachusetts. Many of these mentioned in the urban area, such as Professors Engle, Rothenberg, and Wheaton, are dealing with problems that could also be included in this classification, for example, urban decision making, tax and fiscal problems, optimal provision of services, and the like.

The major interest of Professor Hal R. Varian is a theoretical solution to the problem of distributive justice and equity as a guide to government policy. The work in this broad area will be stimulated substantially by a generous three-year grant from the Sloan Foundation, primarily to support graduate student research in this broad area of applied microeconomics. Under the direction of Professor Temin and with the participation of Professors Joskow, Piore, and Wheaton, this research will be aimed toward a greater understanding of regulatory processes, broadly defined, and the interaction of these with the economic process.

Professor Paul A. Samuelson continues to produce a wide range of theoretical papers. Two projects with investigators from different departments are in dynamic demography (with Professor Joel R. Yellin of the Technology Studies Program) and theoretical economic and stochastic processes (with Professor Robert C. Merton of the Sloan School). Other examples from this year's work further previous research on index numbers and the measurement of real income, and examine the development of the balanced budget theorem.

Faculty

Professor Karl Jungenfelt of the Stockholm School of Economics was a visitor in the spring term. Regular faculty on leave in the spring term were Professors Piore and Franklin M. Fisher.

I am pleased to report the promotions of Associate Professor Piore to Professor, of Associate Professor Stanley Fischer to Associate Professor with tenure, and of Assistant Professor Joskow to Associate Professor. Dr. Rudiger Dornbusch was appointed Associate Professor in international finance and monetary problems.

Unfortunately, we will also be losing some faculty. Professor Harris, who has made important contributions in economic development and regional economics and who helped link the Department with the Department of Urban Studies and Planning, has resigned to become the Director of the African Studies Program at Boston University. Professor Engle, a contributor to econometric analysis, a key member of the group developing the Boston Urban model, and a respected teacher, has resigned to accept an appointment at the University of California at San Diego.

Professor Harold A. Freeman retires to a Senior Lectureship after a remarkable 42 years of service on the teaching staff. He has been a concerned and popular teacher of statistics, and through his interest in and contribution to design and analysis of experiments had substantial involvement with students from all over M.I.T. Many brought him problems to solve that they had encountered in their own work; few were disappointed in the answers he gave, often after considerable effort. His early research was in industrial statistics and quality control; he was a member of the Statistical Research Group that developed sequential
sampling analysis. His later work has been in time-dependent probability. We console ourselves with his part-time service, but see no way that he can really be replaced.

Members of the faculty have been honored in many ways. Professor Franco Modigliani serves this year as President of the American Economic Association. Professor Bhagwati was awarded the first Mahalanobis Memorial Medal by the Indian Econometric Society. Honorary doctorates were awarded to Professor Kindleberger by the University of Ghent, to Professor Samuelson by the University of Southern California, and to Professor Solow by the University of Paris and by Williams College.

E. CARY BROWN

Department of Foreign Literatures and Linguistics

Two events of more than routine interest, both of them "firsts" for the Department, serve as opening and closing punctuation marks for the year under review. These were the first Soviet-American Conference on the Russian Language (SACRL) held at M.I.T. in October, 1974, and the Workshop on Formal Problems in Phonology held in June, 1975.

The SACRL brought together theoretical linguists and specialists in language pedagogy to consider present and future applications of linguistic research to the teaching of Russian at the American college and university level. Some 350 specialists from the Western hemisphere and six Soviet scholar-teachers from Moscow University and the Pushkin Institute attended the Conference, which heard 67 papers and discussions plus several practical workshops conducted by the Soviet participants. M.I.T. participants who presented papers were Professors Robert C. Channon, Catherine V. Chvany, Morris Halle, and Lecturer Mark J. Elson. Approximately 30 revised papers written by SACRL participants, including those from this Department, will appear in 1975 as Volume 19 of the Slavic and East European Journal.

The Workshop on Formal Problems in Phonology was attended by the faculty and students of the Linguistics Section of the Department and some 40 invited guests, most of the latter being Departmental alumni. The Workshop thus constituted the first sizable, though far from complete, gathering at the Institute of graduates of the Department. As the name suggests, the purpose of the Workshop was to discuss work in progress rather than problems whose solution has been found or is in sight. Seven papers were presented and discussed: "Disjunctive Order and Unique Variables" by Professor Halle; "General Variables" by Dr. Jean-Roger Vergnaud, an M.I.T. alumnus, now at the Université de Paris-Vincennes; "Autosegmental Treatment of Vowel Harmony" by George N. Clements, Visiting Scientist; and the following papers by graduate students, "Treatment of Iterative Rules" by Alan S. Prince; "Autosegmental Theory: An Overview" by John A. Goldsmith; "Tonology of Japanese Dialects" by Shosuke Haraguchi; and "The Intonational Realization of Stress in English" by Mark Y. Liberman.

In the period bounded by the events just mentioned, the Department of Foreign Literatures and Linguistics had a reasonably successful and productive year both in its teaching programs and in the research activities of its members.
Despite the drastic decline in enrollment in foreign languages and literature reported by most colleges and universities in the United States (for example, drops of 29.8 and 25.2 percent since 1970 in French and German, respectively, according to surveys made by the Modern Language Association), our Department's undergraduate enrollments have remained essentially steady, with conspicuous increases in French Literature and Spanish. Our success in this respect may be due, in part, to the changes in the Institute Requirement in Humanities, Arts, and Social Sciences that went into effect in the academic year 1974-75. In previous years, Departmental subjects were applicable to the Requirement in extremely limited ways -- a situation felt by most Department members to be unjustly discriminatory, and a source of considerable resentment. Under the new Requirement, all undergraduate subjects offered by the Department may be counted at least as electives, some dozen have been approved as Distribution subjects, and a Field of Foreign Languages and Literature has been recognized in which a variety of programs of Concentration are available. This new found recognition, incidentally, has contributed to an improvement in the morale and self-esteem of teachers of undergraduate subjects. The success of the Department in maintaining undergraduate enrollment is also due, in part, to a generally outstanding level of quality in curriculum planning and teaching performance, as reflected, for example, in student "Course Evaluation Guides," in which this Department's ratings are first at the Institute.

This year the Department housed the small program in English for international students that had previously been associated with the Department of Humanities. Our Department has provided a congenial milieu for this program, among colleagues with similar pedagogical interests, along with the basic administrative necessities, office space, and some financial assistance for films, tapes, etc. There is, however, an urgent need for coordination with other Institute programs dealing with the problem of English language competence, for example, the Technology Matrons' program and one sponsored by the Office of Personnel Development for employees. In addition to the fact that resources are spread over the Institute and are not coordinated, there are problems with the academic status of the various programs. There are some options for undergraduates to receive credit for subjects in English for international students. This seems desirable for some students, but it is a social fact that many do not wish their language incompetence to be identified, and are thus reluctant to register for the training which they need. Additionally, linguistic segregation, isolation, and lack of articulation with the rest of the community pose problems for foreign students and for their families. It seems that the most appropriate vehicle for the development of a coherent program in English for speakers of other languages in the Institute community would be to create a center involving the joint participation of the Department of Foreign Literatures and Linguistics, the Foreign Student Office, the Dean for Student Affairs, and the Dean of the Graduate School. It will be necessary to include within this center sufficient personnel to permit systematic outreach programs, diagnostic services, and formal instruction in both spoken and written English. Discussion of the many dimensions of the problem at hand have been initiated among representatives of the Department, the Foreign Student Office, the Psychiatric Service, and the Office of the Provost.

Russian House, though administratively a part of the dormitory system, has long been a valuable adjunct to the language teaching operation of the Department. This year, we welcomed the addition of French and German House. These quasi-independent living groups each have 12 or more students and a resident tutor who is a native speaker or teacher of the language. The use of English is banned within reasonable limits except, for example, while doing homework in physics or talking with monolingual English-speaking visitors. Living in a language House complements but does not substitute for taking language subjects. However, some students who could not fit language subjects into their schedules have found the language House to be indispensable in maintaining their language ability. The language Houses also have subscriptions to foreign periodicals,
School of Humanities and Social Science

show foreign movies, and entertain foreign guests such as professors from various departments at the Institute, exchange students, and visiting scientists. The three language Houses will move to more adequate quarters in New House to be opened in fall, 1975.

Research

As in past years, the research of the Linguistics Section has been directed toward extending our understanding of natural language, the acquisition of which is one of the most complex intellectual achievements accessible to all normal humans. In the last 20 years there has developed within linguistics a tightly organized theory which in depth, formal complexity, and precision surpasses practically all similar attempts in the social sciences. The work of the Linguistics Section is primarily concerned with elaborating and testing this theoretical framework, which, in spite of its relative sophistication, is far from complete. Within the Section, several distinct approaches to the basic question of the character of the logical structure of linguistic theory are represented.

Professor John R. Ross has challenged the long-standing assumption that linguistic phenomena are discrete, and that therefore grammars which describe linguistic phenomena (and of course, linguistic theory which describes these grammars), must also be discrete. Accordingly, much of his work has attempted to lay the foundations for a nondiscrete theory of language.

Professor David M. Perlmutter, working closely with Dr. Paul M. Postal of International Business Machines, has been developing the theory of Relational Grammar, which integrates two fundamental ideas of established traditions. From Transformation Grammar, Relational Grammar incorporates the distinction between underlying and surface levels of representation related by systems of rules. From Traditional Grammar, it incorporates the notion that the relational terms "subject of," "direct object of," and "indirect object of," are theoretical primitives that play a central role in grammar.

Professor Noam A. Chomsky's work has concentrated on somewhat narrower questions. Continuing a line of investigation that has come to be known as the "extended standard theory," he has pursued the development of general conditions on transformations and the closely related "trace theory of movement rules," which provides a revised notion of surface structure with many of the desired properties of representations of logical form. This work suggests that the theory of grammatical transformations can be radically improved in the direction of eliminating much of its excessive descriptive power by means of general constraints on rules and properties of surface structures.

Phonology continues to be a major area of research in the Linguistics Section. An entirely new line of investigation is the development of the theory of "autosegmental phonology," to which a number of graduate students have made important contributions, notably Messrs. Goldsmith, Liberman, and Haraguchi. It has long been the practice of linguistics to indicate so-called "supra-segmental features," mainly pitch and stress, as special diacritic marks on particular segments of phonological representations. The essential innovation of the "autosegmental" theory is to formalize suprasegmental representation as a sequence of discrete units parallel to, but distinct from, segmental representation. The specific content of the theory lies in the formal mechanisms whereby the units of one level of representation are associated with the (typically non-identical number of) units of the other. The results of these explorations to date constituted a major portion of the material discussed at the Workshop on Formal Problems in Phonology mentioned earlier in this report.
Other research on phonology that deserves mention is work on the formalization of various abbreviatory devices, carried out mainly by Professor Halle and Mr. Prince in collaboration with Dr. Vergnaud. Also, research on the accentual systems of Indo-European languages by Professor Paul Kiparsky and Professor Halle suggests that a solution will be available soon for one of the most difficult problems of Indo-European phonology, namely, the reconstruction of the Indo-European accent system.

Along with research on the foundations of syntactic and phonological theory, descriptive work on problems of particular languages has been carried out by various members of the Linguistics Section. Especially interesting are investigations by Professor Kenneth L. Hale of relative clauses in a number of native languages of North America (primarily members of the Uto-Aztecan and Athabaskan language families) and Australia (Lardil, Walbiri, and the Arandic languages of Central Australia). These languages exhibit relative clauses whose superficial structures are radically different from those which are generally assumed for more amply studied languages such as English and Japanese. In some instances the results of these investigations have forced a reconsideration of certain putative linguistic universals; in other instances they have provided striking confirmation of general theoretical proposals based on the detailed study of English that has been a primary focus of interest in the section.

The study of native North American languages has had another, quite different effect. As a result of the work of the American Indian students in the Department and of their special interests, we have become quite aware of the need to address the question of what role, if any, theoretical linguistics has to play in education. This question has been studied in the context of the place of Navajo linguistics in the developing bilingual education program on Navajo reservations. There seems to be considerable promise in the idea that the study of the Navajo language should form a part of the science curriculum in these programs. Because of the immediate accessibility of its primary data, linguistic science provides an excellent framework in which to teach the essentials of scientific method. The research required to explore and develop this idea includes not only study of the language of specific school-age populations, but also work leading to the development of effective techniques for teaching science through linguistics at primary and secondary levels. This work has been initiated on an informal basis, and we hope to begin a more formal program of research in the near future.

Research in the Language/Literature Section, though not directed toward a common goal as in the Linguistics Section, has been substantial. Professor Martin Dyck has made a public presentation of his "Irrelation: A New Theory of Literature," and continues to work on a new theory of comic universals, among other long-term projects. Professor Robert E. Jones, having completed a book on Gérard de Nerval, has turned to studies of Lenormand and Tennessee Williams. Professor Krystyna Pomorska has published a book on Pasternak and has made other contributions to Slavic studies, especially the works of Pushkin, Solzhenitsyn, and Ukrainian folk songs. Dr. Ilona Ricardo, a Lecturer in the Department, continues her work on a book on Voltaire. Lecturer Magda Tisza has begun a study of the way women are traditionally portrayed in foreign language textbooks. Professor Marcia Williams is working on a critical edition and translation of the Loi du Conseil.

Publications

The publications of both the Language/Literature group and the Linguistics group of the Department during the year are impressive, even when only full-length books are listed. These include the following: Noam A. Chomsky, Peace in the Middle East?, New York:

We should also mention that the journal Dine Bizaad Nanil'ijji Navajo Language Review continues into its second year under the editorship of Paul Platero, graduate student.

Faculty

We record with sorrow the deaths of Herman Klugman, Assistant Professor of Modern Languages, Emeritus, and George A. Znamensky, Assistant Professor of Russian, Emeritus.

Professors Channon and Chvany were the local organizers of the Soviet-American Conference on the Russian Language mentioned earlier. Professor Chvany was chairman of the Methodology Section of the annual meeting of the American Association of Teachers of Slavic and East European Languages, and chairman of the Slavic Linguistics Section of the annual meeting of the Modern Language Association. She also has been elected treasurer of the Massachusetts chapter of the Modern Language Association.

Professor Chomsky was invited to deliver the distinguished Whidden Lectures at McMaster University, Hamilton, Ontario, in January, 1975, among numerous other invited appearances.

Professor Dyck has been elected to serve on the editorial board of Historia Mathematica and has presented papers at a number of national professional meetings.

Professor Hale served as a consultant on Northern Territory bilingual education for the Australian Ministry of Education.

Professor Halle completed a term of office as president of the Linguistic Society of America.

Professor Jones is the chairman of the committee on the Institute Requirement in the Humanities, Arts, and Social Sciences.

Lecturer Claire Kramsch is chairman of the Pedagogic Committee for the Ecole Bilingue of Belmont.

Ms. Tisza and Professor Williams were on leave during the fall term. Professor Williams was awarded an Old Dominion Fellowship for study of medieval French literature.

JAMES W. HARRIS

Department of Humanities

This year was the first in which the new Institute Requirement in the Humanities, Arts, and Social Sciences prevailed, and there was some anxiety as to what its effect would be
on the Department of Humanities. In fact, the effect on enrollments was relatively small. The total enrollments in Humanities dropped from 3,724 in 1973-74 to 3,448 in 1974-75. This drop, however, must be seen as part of a longer-range trend, wherein the Department went from 5,621 students enrolled in its subjects in 1965-66 to a high point of about 7,000 in 1968-69, 1969-70, and 1970-71, then dropped to 5,128 in 1971-72, and to 4,508 in 1972-73.

While the large drop between 1970-71 and 1971-72 is mainly accounted for by the separation of Philosophy from the Department, the downward trend must of course be attributed to other factors, primarily the increasing opportunity for M.I.T. students to fulfill their Humanities Requirement in ways other than that provided for by this Department. With its semimonopoly broken, the Department seems nevertheless to have weathered this development in surprisingly good shape, attesting to the students’ strong interest in humanities, whether required or not. Still, any further decline would be a matter of some concern. (The number of students majoring in Humanities will be discussed separately).

If one turns from student numbers to the content of the Department’s offerings, there has been a marked expansion. The Literature Section has in recent years almost doubled the number of subjects offered. Crossroads in the Western Tradition has increased to about eight subjects and is widening its interdisciplinary links in the hope that faculty from various disciplines and other departments will participate in its efforts. In its first year as a quasi autonomous program, the Writing Program has made a strong beginning. Program Co-Coordinator, Professor Patricia Cumming, received a Danforth Fellowship to “improve teaching and learning;” during fall, 1975 she will work with M.I.T. faculty and undergraduate teaching assistants on methods of teaching writing. Lecturer Joseph S. Brown received the Everett Moore Baker Award for Outstanding Undergraduate Teaching. For their work in establishing the Writing Program, Technical Instructor Kenneth Skier and Instructor Seth Racusen received M.I.T.'s first Dean Irwin Sizer Award "for the most significant improvement to M.I.T. education." A new subject in the arts, Words and Images I: Writing and Television, was funded by a Sloan Grant in Telecommunications and Education and taught by Technical Assistant Daniel DeHainaut. Technical and specialized writing instruction was provided by Co-Coordinator Professor Robert R. Rathbone, through guest lectures in science and engineering classes, thesis consultation, and 21.10 Scientific and Engineering Writing. As part of the effort to bring writing instruction into other departments, Mr. Skier conducted a writing workshop for civil engineering students in the fall, and, for the spring term, developed a special subject for Sloan School undergraduates: Writing for Management. The Program received a gift of $6,000 from an alumna who had taken a writing class as an undergraduate and wished to help keep sections small. And, for the third year in a row, enabling grants were awarded to advanced writing students, providing them with the time to work on writing projects during the summer. Finally, Writing Program faculty members and former teaching assistants are looking forward to the publication of their book, Free Writing: A New and Simple Method for Teaching and Learning Writing, which will be available from the Hayden Book Company in early 1976. In drama, Professor Albert R. Gurney, Jr. took advantage of a Sloan Foundation Grant for Telecommunications and Education to develop a new three subject sequence in acting, with special emphasis on the use of video equipment as a teaching tool. A decision must be made soon as to whether an expanded program in drama can and should be sustained at M.I.T.

The Department has also reached out to the larger academic community of the Institute in various ways. For example, relations with the Technology Studies Program are being encouraged, and its subjects are being offered through Course XXI. The new masters degree program in Technology and Policy has provided for the participation of a member of the Department of Humanities in the proseminar planned for next year. As is reported later in some detail, the Cambridge Humanities Seminar continues to provide a setting in which members of this Department work with faculty from surrounding universities in a common humanistic enterprise.
One of the continuing needs of the Department is to clarify the aims of its various disciplines and to stimulate a more vigorous intellectual life, provocative of greater research and scholarship. To that end, three colloquia under the able direction of Professor Alvin C. Kibel, were held on the subjects of "What is History?"; "What is Literature?"; and "What is Humanities?". Professors Fritz Ringer (History, Boston University), Stephan Marcus (Humanities, Columbia University), and Geoffrey Hartmann (Literature, Yale University) participated in these colloquia, whose central purpose was to examine various conceptions of how the several disciplines carry out their activities. Partly emerging from these colloquia is a plan to have workshops in history and in literature during 1975-76. The workshop in history had a planning session in late spring, and it was agreed that the topic for next year would be the family in historical perspective. This would be part of a long-range inquiry into industrial society in historical perspective. The workshop for literature is now in the initial planning stage. To give students a better idea about the various disciplines in the Department, brochures have been planned with information not available in the catalogue on the various tracks provided for in the specific disciplines of the faculty involved, and the interests and backgrounds. An additional brochure describing our programs was put together by Course XXI students and mailed out to all of the applicants accepted by M.I.T. for the forthcoming year. The hope is that more students with an interest in the humanities as well as in science and engineering will choose M.I.T. if they are given a better idea of the kind of humanities work they can do here.

The Department has mounted a vigorous program of lectures from outside, bringing fresh ideas and people to the Department. Such lectures have ranged from "Scholarship on the Old Testament" to "Reports on Field Work in Anthropology" and "Reports on Art History." This effort, along with many other aspects of the general attempt to stimulate intellectual activity in the Department, has been supported in part by the fund-raising activities of I. Austin Kelly III. His formation of the Friends of Humanities, and the contributions he and they have made, have given the Department a profound sense of moral as well as financial encouragement. It cannot be stressed too strongly that for the first time the Department has a small source of support to permit undertakings which cannot be covered by the general budget.

Administratively, there has been clarification as to how the Department should order its affairs. A more clear cut definition of the duties of the Department Head and the Section Heads is not established. It is plain, however, that the structure of the Department and its way of administering its affairs is a continuing problem. It is also clear that developments in the Department have to take place within the context of developments now under way throughout the School of Humanities and Social Science.

Intellectually, the Department needs to get a clearer sense of its mission and of its professional identity, while maintaining its admitted competence in teaching. A greater sense of professional excitement needs to be generated in the Department. Some of this must come about through new programs, and some by the greater articulation of existing programs. All in all, it is essential that we regenerate a sense of forward movement and develop a keener sense of intrinsically participating in the central purposes of M.I.T., rather than feeling partially alienated from the rest of the Institute. An intangible but important sense must be fostered, emerging from many individual tangible steps, of what it is to be a Department of Humanities that is essential to the life of the students and to the intellectual concerns of the Institute as a whole. This is the direction in which the Department is seeking to move.

BRUCE MAZLISH
In 1974-75 the Program's faculty finally reached a workable size with the addition of Instructor Wilma E. Wetterstrom, an archaeologist specializing in the New World and in ethnobotanical studies. At the same time our new curriculum was offered in its entirety for the first time; it consists of an introductory subject, three middle level subjects attempting to give an overview of the complexities of anthropology, and upper level specialized subjects in the various branches of anthropology and archaeology. Work continues on revising several of these subjects after our first experience with them in the classroom. A new subject, Nutrition in Sociocultural Systems, taught this spring by Professor Martin Diskin, attracted students from the Departments of Humanities and Nutrition and Food Service. Professor James Howe's Independent Activities Period (I.A.P.) subjects on ethnographic filmmaking and witchcraft also helped to publicize anthropological activity at M.I.T. Members of the Program presented reports of their research in progress at well attended colloquia at M.I.T. this spring. Among new subjects developed by members of the Program for next year is Metallurgies in Ancient Societies, which will be taught by a group of archaeologists and metallurgists from M.I.T., Harvard University, Tufts University, Boston University, and Brandeis University.

Professor Heather N. Lechtman returned from a year of field work in Peru, having found a number of ancient metallurgical sites to which she will soon return for closer investigation. During the spring, Professor Lechtman organized and chaired an important symposium, "Style in Technology," at the American Ethnological Society annual meeting.

Professor Arthur Steinberg gave a paper on "Technological Styles in China, Anatolia, and Central Europe" at the symposium chaired by Professor Lechtman and continued his research on the development of copper-smelting technology in ancient Cyprus. Professor Steinberg also was elected president of the Boston Society of the Archaeological Institute of America.

Professor Diskin has coedited a book with Scott Cook of the University of Connecticut on the economics of peasant marketing in the Valley of Oaxaca. The book, Markets in Oaxaca, is being published shortly by the University of Texas Institute of Latin American Studies and by the Instituto Nacional Indigenista of Mexico. They also coorganized a symposium at the annual meeting of the American Anthropological Association in Mexico City on "Regional Economic Systems of Mexico." Professor Diskin is leaving for a year of field research in Oaxaca where he will continue work on peasant marketing systems, this time with an emphasis on the regional distribution of nutrients.

Professor Jean E. Jackson finished an article on "Recent Ethnography of Indigenous Lowland South America" for Annual Review in Anthropology, as well as giving a paper on her research on the Colombian Vaupes Indians at a meeting funded by the Mathematics Social Science Board and participating in a symposium of the American Anthropological Association. She was awarded an Old Dominion Fellowship to continue her fieldwork in South America in 1976.

Professor Howe returned to Panama this summer on a National Endowment for the Humanities grant to continue his work with the San Blas Cuna peoples. During the year he wrote two papers, one for the American Ethnologist and the other for Hombre y Cultura, on various aspects of his research among the Cuna Indians.

Professor Wetterstrom, who arrived at M.I.T. in fall, 1974, has become deeply involved in curriculum planning and is working on setting up an ethnobotanical teaching laboratory.
where she will process plant remains, including material from New England archaeological sites. Some of her work on nutritional analyses of archaeological food complexes was presented at the meetings of the Society for American Archaeology.

ARTHUR STEINBERG

History Section

The introduction of the new Institute Requirement in the Humanities, Arts, and Social Sciences resulted in the History Section's devoting much time and effort to a further revamping of the Section's subject offerings. In European history, the curriculum includes a series of basic subjects which deal broadly and comparatively with specific historical periods from the Middle Ages to the present; a group of subjects in the history of different nations which stress particular institutional and cultural traditions; and a series of advanced subjects which deal with these materials in terms of a single topical or methodological approach. These sequences are designed to encourage learning in progressively greater depth and to combine a solid grounding in historical fundamentals with an exposure to specialized techniques of historical analysis. In American history, the program is constructed along the same lines, and there are also subjects in the history of non-Western areas which stress their links to the values and technology of the industrialized world. Finally, there are interdisciplinary and special programs, such as American and Russian Studies, in which members of the History Section participate.

Interviews were held with candidates for a post in black history, and the appointment of Monroe Little will be announced during the forthcoming year.

It is a pleasure to announce that the distinguished American historian Henry Steele Commager will be a Visiting Professor during the fall term, 1975, and will offer a subject in Foundations of American Nationalism, 1774-1815.

Professors Arthur D. Kaledin, David B. Ralston, and William B. Watson were on leave this year. Professor Kaledin will continue on leave for the next academic year, and Professors Ralston and Watson will return to their regular schedule in the fall. Professor Emeritus Lynwood S. Bryant completed his postretirement teaching in the Section, serving in fall, 1974, as a Senior Lecturer.

Finally, members of the Section continued to participate in a number of scholarly endeavors which included papers before professional societies, research, and publication. Especially noteworthy was the appearance of Professor Bruce Mazlish's widely noticed James and John Stuart Mill: Father and Son.

THOMAS H.D. MAHONEY

Literature Section

This year the Writing Program was given quasi-autonomous status from the Literature Section, so that now when we speak of the literature faculty we specify a rather smaller group than in the past, a group likely to become smaller as a result of current budgetary constraints. We end this year with two fewer faculty members than we began it with, and
we will end the next year with two or three fewer than at the start. Still, the activities of the section and its faculty are manifold. For example, Professor Kibel published essays in Victorian Studies and in the American Scholar; Professor Louis Kampf, an essay in New Literature History. A volume of Professor Barry B. Spacks' poems, Teaching Penguins to Fly, was published earlier this year; indeed during the year his poems were everywhere: The New Yorker, Atlantic, Esquire, Ploughshares, etc. And members of the Section lectured, read, or performed to the north, south, east, and west: Professor Kampf lectured at State Universities of New York up and down Long Island, and in France; Professor Wayne O'Neill at Harvard University, Amherst College, and in Illinois; and Professor Spacks read at Suffolk University and talked in Fredonia.

Here at M.I.T., Professor Murray J.K. Biggs launched his student Shakespeare Ensemble with a successful production of Twelfth Night and acted the main part in the Cambridge People's Theatre production of Wycherley's The Country Wife. And Professor Gurney began developing an expanded program of subjects in drama.

We all struggle with the problems of curriculum, mainly by developing a coherent set of literature distribution subjects and a newly ordered literature major program. We now look forward to designing a new introductory subject in literature and expanding our "period" offerings.

New Programs and mini programs continue to develop out of the Literature Section: Crossroads, American Studies, Women's Studies, the Writing Program, and Cambridge Humanities Seminar. We hope to remain through these difficult times the well-spring from which good literary things can flow. It will not be easy.

WAYNE O'NEIL

Music Section

The Music Section enjoyed its most productive year from the standpoint of enrollments, student musical group participation, and concert activity on campus. A number of new subjects and seminars emphasized performance; the piano laboratory became a reality thanks to a contribution from the Council for the Arts of M.I.T. for five pianos; and the Chamber Music Society became a full-fledged participant in M.I.T.'s concert life.

The faculty collectively had an interesting and productive year. Professor David M. Epstein conducted the premiere of his work "Night Voices" commissioned by The Boston Symphony Orchestra; he also finished a book on musical structure to be published by the M.I.T. Press. Conducting activities took him to England with the Royal Philharmonic and to Harrisburg, Pennsylvania, where he served as Music Advisor and Conductor of the Harrisburg Symphony. Professor John Harbison took a leave of absence in the fall to finish an opera based on Shakespeare's "A Winter's Tale" and started a number of other commissioned projects; he also conducted the Boston Philharmonia in one of its subscription concerts. Professor John L. Buttrick went on a concert tour of Switzerland, Austria, and England, performing solo and chamber concerts, and he began a recording of the complete Chopin Mazurkas in Zurich.

Professor Barry L. Vercoe received a grant from the National Endowment for the Arts (NEA) for further work on the experimental studio at M.I.T. Professor Stephen Erdely also received a grant from the NEA, this one for urban folklore studies; he continued his reviewing for Ethnomusicology and The Year Book of the International Folk Music Council.
Professor Donald Sur had new works played locally, in New York City, and at the Holland Festival in Amsterdam.

Professor Rufus E. Hallmark finished his dissertation on Schumann's "Dichterliebe" prior to receiving his Ph. D. from Princeton. He also had book reviews published in *JAMS* on Schumann's songs, while continuing as tenor soloist for the Camerata Singers. Professor Marcus A. Thompson took a tour to Central America and spent the summer performing at the Santa Fe Chamber Music Festival. Professor Martin D. Farren completed a commission from the Black Earth Percussion group, utilizing an acoustic notation system he had developed; this work was played initially at the University of Illinois and later at Yale University.

Among lecturers and instructors, John S. Oliver continued his choral conducting at Tanglewood and for the Boston Symphony Orchestra winter concerts. Timothy C. Aarset recorded "A Medieval Christmas," and "The Motets of Adrian Willaert," while serving as assistant director to the Boston Camerata. Adrianus J. M. Houtsma continued consulting and joint participation with companies involved in instrument acoustical research and development, while continuing to build his laboratory facility at M. I. T. with the help of Ignacio H. Garabieta-Orueta, Technical Instructor in the Department of Architecture, and Mr. Aarset.

The faculty as a whole has taken on a number of new seminars and musical groups to broaden the variety of musical activity available to M. I. T. students of all levels of achievement. The basic introductory subjects especially remain the heart of the music program; the increase of students in this area is gratifying, and the interest in further musical study is on the rise after a couple of flat years.

We have high hopes for the Seminar in Music, Linguistics, and Aesthetics, which is an experimental group of faculty and students from the Boston area interested in new ways of thinking about music as a perceptive language. The Experimental Music Studio and work on acoustics continue to command a small but select audience.

The budgetary crisis puts some of the activities of this Section in doubt for the next couple of years; performing groups are badly hurt by inflation, concerts by outside groups become more expensive, and the upkeep of the expanding number of instruments we have is more difficult. Additionally, the increasing number of students playing music puts a bigger burden on all resources, especially space, and there is apparently no equitable way to solve this problem short of major new facilities for the arts at M. I. T. It is to this problem that we must address ourselves in the immediate future, for the arts have become too important a part of the collective student life here to be handicapped by the lack of adequate and appropriate space.

JOHN L. BUTTRICK

Course XXI

Course XXI entered the academic year 1974-75 directed jointly by Travis R. Merritt, Associate Professor of Literature, and Louis L. Bucciarelli, Associate Professor of Engineering and Technology Studies. This arrangement was designed to bring the central humanistic concerns of Course XXI into a closer working relation with the scientific and engineering interests which affect many of our students. During the past year, most of the day-to-day administrative functions of our office were handled by Professor Merritt; Professor Bucciarelli contributed strongly to policy discussions, most significantly those...
bearing on the joint degree programs (XXI-A; XXI-B, 1), and was an invaluable partner to Professor Merritt in the Humanities Senior Seminar. The pattern of shared management responsibility, while still evolving, is a promising one.

There are signs that the recent steady decline in numbers of Humanities majors has been arrested, although not yet clearly reversed. During the spring term there were 58 registered students in Course XXI, 24 in the joint major programs (ten in XXI-A, 14 in XXI-B, 1) and 34 in the full humanities major (XXI-B, 2). Significantly, juniors slightly outnumber seniors in this count (25 to 23). The number of declared sophomores (in this case, ten) is never a reliable indicator, since so many eventual Humanities majors do not declare until the junior year or the very end of the sophomore year at the earliest. The size of the third-year group is the best key to emergent trends, and there we seem to be holding our own.

Six undergraduates received the Course XXI degree in February, 1975, and 16 in June. Of the total of 22, 13 were in the XXI-B, 2 program (six in Literature, two in Writing and Literature, two Major Departures, and one each in Music, Anthropology-Archaeology, and History), four were in XXI-A and five were in XXI-B, 1. Five students were elected to Phi Beta Kappa: Brian Lustbader, Aftab Omer, Todd Sjoblom, Neal Vitale, and Roy Wyman. Literature accounts for nearly half of our majors (26) presently, with Music (13) and the Writing Program's new Writing and Literature major (8) showing considerable strength. The other programs--Anthropology/Archaeology, History, Philosophy, American Studies, Russian Studies, and a miscellaneous category representing "major departures" from the standard curricula--show only a thing scattering of majors. There is clearly a need for more effective efforts to attract qualified students to the History and Anthropology/Archaeology majors in particular.

This was the first year of major status for programs in American Studies (XXI-A, XXI-B, 1), Russian Studies (XXI-A XXI-B, 1), and Writing and Literature (XXI-A, XXI-B, 1, XXI-B, 2). The results, thus far, have been mixed.

American Studies: This program has drawn a reasonable amount of student interest -- there have been numerous inquiries about it, and a couple of majors have declared for it -- but most of its potential has yet to be realized. The American Studies curricular listing includes a great many subjects, some offered within the Department of Humanities and some by other departments. A wide variety of suitable combinations is readily available to any students who wants to pursue American Studies in depth. What is needed is a more coherent and identifiable definition of the program's educational goals, more active collaboration and consultation among those who teach the subjects, and more participation from other departments.

Russian Studies: The prognosis here is more guarded. The Russian Studies listing contains relatively few subjects -- fewer, in fact, for the coming year than for 1974-75. Although several of these subjects enjoy moderately high enrollments, students have shown virtually no interest in the major program as such. The entire enterprise will need to be thoroughly assessed next year, with a view toward either strengthening or suspending it. Like American Studies, this is a program whose chances for long-term success depend very much upon support from other departments.

Writing and Literature: This major, energetically promoted by the Writing Program, shows early promise of considerable popularity among M.I.T. undergraduates. Its future as a program under Course XXI will be affected by the evaluation of the Writing Program currently being carried out by a special committee. Since the degree program at present requires almost as many subjects in Literature as in Writing, there may be a need to distinguish it more plainly from the programs in Literature (which also admit subjects in Writing), or at least to establish territorial prerogatives in a sharper way.
Among the several established programs in Course XXI there were this past year several minor modifications in the degree requirements. The only profound change came from the Literature Section, which restructured its full major program (XXI-B, 2) to include a range of chronological coverage in elective subjects and a three-term sequence of seminars designed expressly for majors.

A serious problem for Course XXI, in the view of the Directors, is the state of the joint major programs (XXI-A, and XXI-B, 1) which in many cases amount to little more than a strong minor on the Humanities side and even less than that in Engineering or Science, with negligible connection between the two. Last fall, after a series of conversations with Professor Kible and several other members of the Humanities faculty, Professors Bucciarelli and Merritt drafted a proposal calling for significant revision of these programs. A revision of that proposal is now in process, involving consultation with interested persons and groups from various sectors of the Institute.

During the past several years, and especially during 1974-75, it has become increasingly clear that the Institute's "image" and admissions policies constitute a peculiar difficulty for Course XXI. None of the ventures already described in this report -- the new programs, the efforts to make the requirements for full majors more coherent, the scheme for strengthening and augmenting the joint major programs -- is likely to make a sufficient difference in the quality and status of serious humanistic study here unless there can be a concurrent effort, energetic and sustained, to bring more students to M.I.T. who have primary interest in the humane disciplines. Course XXI is anomalous in that, with very rare exceptions, all of its majors are converts (often rather late converts) from other fields. This situation, while challenging and therefore stimulating, is not altogether healthy. The opportunity to correct it seems to be at hand, since the Institute is now considering ways of increasing undergraduate enrollment without sacrificing quality. Early this year, Professor Merritt submitted to the departmental Policy Committee a number of recommendations for action on this front, ranging from more direct faculty involvement in the admissions process to large-scale efforts to alter the outdated "tech school" stereotype which M.I.T. presents to the world at large. Some progress has been made this year, but the main effort remains before us.

This year's version of 21.08 Humanities Senior Seminar, required of all fourth-year students in the XXI-A and XXI-B, 1 programs, represented an experimental departure from the general practice of past years. Instead of relying heavily on participation by "outside" authorities, Professors Merritt and Bucciarelli tried as far as possible to turn the seminar's main business over to the students themselves, in the hope that this would yield a more continuous and enduring educational experience. Each participant was called upon to write frequently in response to the assigned texts as well as to organize and direct one of the three-hour sessions. The results were generally satisfying, although it remains clear that any seminar experience of this type, largely dissociated from the students' central work in particular disciplines, will strike many of the participants as a somewhat arbitrary requirement. This is an issue of educational policy which must be firmly addressed next year.

This past year witnessed the awakening of the Course XXI Society, which has been dormant since the late 1960s. The Society, organized by and for students, seeks to promote intellectual and social community among Humanities majors. This year's activities were highlighted by the institution of a regular weekly social hour, various evening meetings devoted to discussion of curricula and physical environment, a sponsored visit and lecture by the critic Hugh Kenner, and the preparation of a brochure on the Humanities at M.I.T. which was mailed by the Admissions Office to all students in next year's entering class.
Plans for 1975-76 include an expanded series of sponsored lectures, recitals, and performances, extensive refurbishing of the Henry Greenleaf Pearson Room for social events, an information disseminating open house in the fall, and a Course XXI students' newsletter.

TRAVIS R. MERRITT

The Cambridge Humanities Seminar

Operating with a grant from the National Endowment for the Humanities (NEH), the Cambridge Humanities Seminar is a collaborative effort of universities in the Boston-Cambridge area to enrich and diversify their curriculum offerings in the humanities. The program is centered at M.I.T. and includes faculty from M.I.T., Boston University, Brandeis University, and Wellesley College who represent a variety of disciplines. Its central feature is a faculty colloquium that meets for three hours on a biweekly basis with additional meetings scheduled as needed for curricular planning and discussion. The colloquium has two distinct but related tasks: 1) to identify and explore areas deemed most fruitful for interdisciplinary scholarship, and 2) to design subjects which will be taught by members of the seminar to classes of cross-registered students. At the end of three years, we envision a regular program offering a concentration to students in the humanities at participating universities. The program will be offered during the last undergraduate year and the first two graduate years, and will explore a specific area of interdisciplinary scholarship to be periodically determined by the faculty membership, working through the central colloquium.

Such a program would be addressed to three problems, the first of which is of especial concern to M.I.T.:

1) How can we mount a first-rate humanities program, extensive in range and depth, at an institution predominantly oriented towards science and technology?

2) How can universities share their intellectual resources so as to provide their students with the widest choice of educational opportunities without compromising academic quality?

3) How can serious, ongoing programs in interdisciplinary subjects develop a curriculum?

To these ends, the seminar began its planning stages in 1973-74 by proposing several topics for consideration, under the general theme "The Idea of the Past in Science, Art, and Literature." This theme seemed particularly appropriate at a time when consciousness is excessively dominated by the contemporary and the new, with a consequent loss of historical perspective. During the course of this past year, the seminar came to focus on a subject matter naturally suggested by "The Idea of the Past." This subject may be called "Reinterpretation," and it concerns the ways in which art, science, and literature reinterpret works from their past in the light of the present. The following topics indicate the general lines of inquiry.

1) Advocates of modernism in the arts have claimed that it catches up a tendency implicit in our culture since the eighteenth century, namely to divorce artworks from their particular religious or historical contexts and devise more universal or secular modes of access to their meanings. The history of museums could be studied in this connection and their effect on the production of subsequent art; the history of universities might provide an earlier model in its effect upon research
and learning. Texts could include works by Malraux, Walter Benjamin, Germain Bazin, and Clement Greenberg, among others.

2) The claim of present day efforts in science, history, literature, or art to establish a universal context for its activity leads to reinterpreting past work as a progress, a series of steps leading to the present. Still more, it makes past works appear as expressions of a problem solving activity, each step offering definite solutions to problems thrown up by its immediate past and creating new problems for its immediate successors. The extent to which this view is legitimate might be studied in connection with works by Popper, Kuhn, and Lakatos on science and Greenberg, Gombrich, and Lukacs on the arts.

3) The "progress" of the art or science involves questions about the relationship or lack of relationship between its internal history, which expresses the viewpoint of current practitioners, and an external history, which places the activity in relation to some larger whole. Again, a "progressive" history might ignore or tend to undervalue elements that seem, from the modern viewpoint, to have a retrograde or nonfunctional tendency. Works by Mannheim, Weber, Lukacs, and Raymond Williams can be studied in this connection.

4) The attempt to determine a universal context for the activities of art and science has been identified with an exacerbated questioning of values fundamental to our civilization. This self-critical tendency has been viewed ambiguously as a source of nihilism and "dehumanization" in science and art and as a legitimate attempt to establish each of the disciplines more firmly in the area of its competence. This issue suggests the possibility of a general study of the ideas of self-criticism or "critique," starting with Kant, and of its expression in various artistic and literary movements in our century, as well as in the philosophy of science.

5) The effect of democracy, egalitarianism, and the desacralization of the religious life on the possibility of a moral or valuative history of the arts. The texts for such a study can be found in the work of Matthew Arnold, Ortega y Gasset, Walter Benjamin, Marshall McLuhan, and Northrop Frye.

This year we achieved a flexibility in the planning of each session which improved immeasurably the sense of continuity in the series of discussions. After each meeting, a subgroup of the seminar's members examined suggestions for further readings in topics arising during discussion; the group prepared a short bibliography of materials to serve as the basis for discussion during the next session. In this way, it was possible to follow up the discovery of analogues among the various disciplines for certain issues, e.g., the idea of progress, the relation between internal and external history, the relation between value judgment and historical understanding. The unanimous feeling of the group was that during the coming year we should continue to explore and to deepen our understanding of a subject which, right now, appears inexhaustibly rich.

We have also made an important beginning in establishing a curriculum. Following is a list of subjects to be offered in 1975-76 by members of the seminar under the rubric of the Cambridge Humanities Seminar. The subjects have been generated on the basis of the five ongoing topics; classes will meet one afternoon a week for three hours generally at M.I.T. and will involve advanced undergraduate and graduate students from participating institutions.


2) Concepts of Love in the Western World, I. Singer and A. Kibel, M.I.T.
The list does not satisfy our ideal of a thoroughly integrated curriculum, though it is a step in that direction. Such a curriculum will be realized as the seminar continues to develop its subject.

ALVIN KIBEL

Department of Philosophy

The Undergraduate Program

Though this was a productive year for the Department of Philosophy, it was marred by a serious and unexpected drop in undergraduate enrollment, particularly in the core freshman and sophomore subjects that constitute the bulk of the Department's undergraduate offerings. The reasons behind this drop are not clear, particularly since last year the enrollment had gone up. Two possible influences can be cited: a change in undergraduate interests, and the revision of the Institute Requirement in the Humanities, Arts, and Social Sciences. The change in undergraduate interests is dramatically illustrated by 24.01. Contemporary Moral Issues. In 1973, 241 freshmen elected the subject in the fall term and 228 in the spring. This year only 23 students elected it in the fall and only 14 in the spring. Though this drop is much more dramatic than that in other subjects, it reflects a profound change of attitude. The effect of the revision in the Requirement is complicated, but philosophy subjects now constitute a much smaller proportion of the options available to fulfill the Requirement.

Prompted by this situation, the Department has undertaken a review of its offerings. Though this review has only started, it has already resulted in a number of changes. Some distribution subjects will be thoroughly revised and new ones will be offered. The new subjects will include, among others, Classics in the History of Philosophy, Existentialism and Phenomenology, and Freedom and Authority. The previously offered subject Logic, Language, and Science will be redesigned and titled Logic, Language, and Values.

In spite of the drop in enrollment in philosophy subjects, interest in philosophical issues and topics is still lively among M.I.T. undergraduates. A series of lectures offered during the Independent Activities Period (I.A.P.) on various aspects of philosophy was favorably received.

The Graduate Program

The number of graduate applications received by the Department this year is slightly below that of last year, but the quality of the applicants is still high. The enrollment, unfortunately, will not reflect the fact that many exceptional students would like to pursue their graduate
studies here. The Department can offer financial aid to very few of them, and the aid it offers is less than that offered by most competing institutions. The reputation of the Department's graduate program is, however, undiminished. This is reflected not merely by the quality of students who seek admission, but also by its success in placing students. It appears that this year, more graduate students were placed from this Department than from any other department of philosophy (except Harvard University, which placed the same number). Our graduates will fill positions in such prestigious institutions as Yale University, Brown University, and Wellesley College as well as in schools with lesser reputations but which also aspire to high standards.

Research

Besides being involved in teaching, research, and other activities in philosophy specifically, members of the Department also have engaged in interdisciplinary work. Professors Jerry A. Fodor and Ned J. Block organized a conference on philosophy and psychology that met at M.I.T. in October, 1974. The conference attracted a large number of scholars and scientists from the United States and abroad, and led to the formation of the Society for Philosophy and Psychology, which will meet annually on various campuses. Professor Judith J. Thompson participated in the Council for Philosophical Studies Summer Institute on Medical Ethics, where she was a lecturer, and in a conference on the rights and responsibilities of scientists. Professor Irving Singer, with Professor David M. Epstein of the Music Section of the Department of Humanities, led the Seminar on Music, Linguistics, and Aesthetics through its third year at M.I.T. Professor Sylvain Bromberger organized a series of monthly symposia on philosophy and linguistics in which scholars from both fields addressed problems of common interest.

Publications

Members of the Department published articles on a wide variety of topics, including "Molyneux's Problem" and "Academic Freedom and Research" by Professor Thomson, "Arithmetical Sets and Minimalization" by Professor George S. Boolos, and "IQ, Heritability, and Inequality" by Professor Block and Professor Gerald B. Dworkin, formerly of the Department.

Professor Fodor's book The Language of Thought was published by Thomas Crowell, Inc.

Faculty

Professor Jerrold J. Katz will leave M.I.T. at the end of this academic year to accept a professorship at the City University of New York. Professor Katz has been at M.I.T. for 14 years, and his departure from the Department will leave a gap. Associate Professor Boruch A. Brody also will leave to assume the chairmanship of the Department of Philosophy at Rice University. Professor James F. Thomson will be on leave of absence during the spring term of next year to assume the Mills Distinguished Visiting Professorship at the University of California at Berkeley. Assistant Professors Block and Paul G.
Horwich will each be on leave of absence without salary for one term during the coming
year to pursue research. No new appointments to the Department have been made this
year.

SYLVAIN BROMBERGER

Department of Political Science

Now entering its second decade as an independent program, the Department has a national
reputation as a research center, with a strong graduate program committed to the training
of students for careers in college and university teaching and research. For some years
we have given particular attention to the developing areas such as arms control and defense
analysis, international politics and American foreign policy, communist studies, science
and public policy, concepts and methods, political communications and behavior, urban
politics and planning, and the politics of the advanced industrial societies of Western
Europe. A continued research focus of many members of the faculty is on the ways social
science knowledge can be applied to a variety of public policy areas. In recent years, the
Department's concern with urban politics has been broadened to include a wider range of
research and teaching on the American political process, a field that has tended to replace
international affairs as a focus of undergraduate interest.

At the undergraduate level, the Department is seeking to take advantage of the several
distinctive roles it can play within the M.I.T. community. First, while other departments
also are concerned with public policy issues, Political Science is the only department
centrally concerned with the political and governmental process and with the wide variety
of interests and values that underlie public choices. Second, we seek to provide M.I.T.
undergraduates, particularly in our Distribution subjects, with a greater understanding of
the historical and philosophical dimensions of politics and government in the United States
and abroad. Finally, through our internship program, we offer undergraduates public
service opportunities in municipal, state, and Federal government.

The major problems we confront are how to make undergraduates -- few of whom are
likely to be Departmental majors -- aware of the opportunities offered by the Department;
and how to provide graduate training for students who seek public service careers without
weakening our strong program for students committed to careers in scholarship and
teaching. Like other M.I.T. departments, Political Science must adapt to changing needs
at a time when resources for new appointments and new programs are scarce.

Graduate Program

There have been no major revisions in the graduate program this year. The Graduate
Program Committee, chaired by Professor Suzanne Berger, has codified requirements
and procedures and introduced a major improvement in the advisory system. On a
semi-annual basis, both the advisory committees chosen by the students and the Depart-
ment as a whole review the performance of each of the graduate students. The new
procedures, we believe, provide graduate students with closer faculty supervision and
with more detailed information on their individual performance. We continue to emphasize
that one of the distinctive features of our graduate program is the close professional
relationship between graduate students and faculty.
We are gratified by the continued success of our graduate students in soliciting financial support from outside the Institute. This year, five of our students were on National Science Foundation Fellowships, seven had awards from the University Consortium for World Order Studies, two received Foreign Area Fellowships, and three received Ford Foundation Graduate Fellowships for black Americans. As our own funds for the support of graduate students continue to decline, it becomes particularly crucial that our students successfully compete for outside funds. One disturbing development, however, is that faculty research support for research assistants has not been increasing at a sufficient pace to compensate for the decline in fellowships. The funding situation has been particularly acute for students who have completed the first year of graduate studies but are not yet in a position to seek support for doctoral thesis research; some may have to withdraw for a semester or two to earn enough to continue their studies. If this trend continues, many students will take a longer time to complete degree requirements and there may be a decline in the high doctoral thesis completion rate that has thus far characterized our program.

In spite of the stringent job market, students receiving the doctoral degree continue to do well. This year our students have received teaching appointments at the Universities of Washington, Illinois at Chicago Circle, Texas at Austin, Rochester, Yale University, New York University, California at Berkeley, the State University of New York at Buffalo, and The George Washington University. We are particularly pleased to receive word that graduates of our Department have recently received tenure promotions at the Universities of Pennsylvania and Chicago, the Fletcher School of Law and Diplomacy at Tufts University, and the California Institute of Technology.

Two new fields in the graduate program have begun to attract the interests of our students, one in nutrition planning under Lecturer F. James Levinson, and Professors Eugene B. Skolnikoff and Myron Weiner, and the other in political demography under Professors Wayne A. Cornelius, Nazli Choucri, and Weiner.

The Department plans to expand its offerings for the Master's degree and is currently developing programs in arms control and defense analysis, science and public policy, and political development. We propose to admit students in these fields within the existing Master's program for the 1976-77 academic year. A central theme of our expanding activities in these areas will be applied research on public policies leading toward public service careers.

Undergraduate Program

A new office for the undergraduate program has been established, with Professor Jeffrey L. Pressman as its director. Faculty involvement in undergraduate teaching and program development continues to increase, reflected in part by an unusually high level of participation in both the Undergraduate Research Opportunities Program (UROP) and Independent Activities Period (I.A.P.).

While the number of majors in political science has declined since the high point reached in the late 1960s, enrollment in political science subjects has remained level, and this year began to increase, suggesting that a larger number of non-majors are taking one or two subjects in the Department. There has been an increase in enrollment in the introduction to the American Political Process, in American Politics and Social Change (both Distribution subjects), and in Politics and Television.
This year the internship program attracted a larger number of students from all over the Institute. Students were placed in the offices of Congressmen Drinan, Harrington, and Moakley, and in a variety of municipal, state, and Federal offices. This year's program was effectively managed by Professor Christopher Arterton, a recent graduate of this Department, who will be joining the Yale University faculty; next year Professor Alan A. Altshuler will offer a seminar on state and local politics for students in the internship program.

Arrangements have been made for inaugurating an experimental exchange of M.I.T.-Wellesley political science subjects for 1975-76. Two M.I.T. subjects (taught by Professor Lorenzo Morris and Weiner) and two Wellesley subjects will meet once a week, on a rotating basis between the two campuses, in an effort to enroll an equal number of students from the two institutions. Each department will offer subjects that complement those given by the other department in order to expand the curricular opportunities available to students and to facilitate closer faculty and student contacts.

Publications

This has been a highly productive year for members of the Department. A number of books, monographs, and articles, the results of earlier research, were published this year.

The Department continues to remain a major center for research on the developing countries. This year the following studies have appeared:

1) Idols of the Tribe by Professor R. Isaacs.
3) Politics and the Migrant Poor in Mexico City, a volume on urbanization in Latin America; and two edited volumes, Anthropological Perspectives on Latin American Urbanization, and Urbanization and Inequality by Professor Cornelius.
4) Two of four planned volumes, based on a project on electoral politics in India: The Communist Parties of West Bengal, co-edited by Professor Weiner, Electoral Politics in the States: Three Disadvantaged Sectors, co-authored and co-edited by Professor Weiner, and Policy Sciences and Population, a volume on population issues in the developing countries, co-authored by Professor Weiner.
5) Two monographs by Professor Willard R. Johnson on his project on business management for economic development.

In addition there have been innumerable articles and working papers.

Of general interest to the profession is a volume of papers originally presented at the American Political Science Association, edited and authored by Professor Lucian W. Pye, entitled Political Science and Area Studies. Professor Pye also has in press a psychobiography of Mao Tse-tung. In the field of international politics and American foreign policy, attention should be called to two books by Professor Choucri, Nations in Conflict, and Population Dynamics and International Violence. A number of monographs by Professors Hayward R. Alker, Choucri, and Lincoln P. Bloomfield have already appeared from their project on Global Interdependence. Professor Ted R. I. Greenwood's first book, Making the MIRV: A
Study of Defense Decision Making is now in press, and an article by Professor Greenwood on the nuclear debate appeared in a recent issue of Foreign Affairs. Professor George W. Rathjens also published a number of papers on nuclear weapons policies.

Members of the Department have continued to write papers on American policies toward specific countries or regions: Professor Pye on China, Professor Berger on France and Italy, Professor Weiner on India, Professor William E. Griffith on the Middle East, and Professor Rothenberg on South Africa. A volume co-authored by Professor Donald L. M. Blackmer, The International Role of the Communist Parties of Italy and France, appeared this year, while another volume of which he is a co-editor and contributor, Communism in Italy and France, is in press. On American policies and politics, Professor Ithiel de S. Pool has published a number of articles on communications policies, Professor Skolnikoff on U.S. science policy, Professor Harvey M. Sapolsky on Federal research and development programs and health care systems, Lecturer Edwin Diamond on the mass media, and Professor Altshuler on urban transportation policies. Professor Pressman's book, Federal Programs and City Politics, is currently in press, and a second revised edition of Professor Walter D. Burnham's book, The American Party System, has been published. Two volumes edited or co-authored by Professor Michael Lipsky are currently in press, Theoretical Perspectives on Urban Politics, and Riot Commission Politics: The 'Processing' of Racial Crisis in America.

Research and Teaching

Growth continues in interdepartmental and interdisciplinary faculty research, teaching, and program development. Professor Skolnikoff, as Director of the Center for International Studies with which many Political Science faculty are associated, has particularly emphasized new interdisciplinary research on international technology-related issues. Professor Berger participated in a comparative study of dual labor markets with members of the Departments of Economics and Urban Studies and Planning, under a grant from the Ford Foundation. Professor Weiner is the director of a new research program on the study of migration and development, funded by the National Institute of Child Health and Human Development, involving members of the Departments of Economics and Urban Studies and Planning. Professor Choucri is participating in a course on the transfer and adaptation of technology to developing countries, offered jointly by the Departments of Political Science, Economics, and Civil Engineering. Professors Greenwood and Rathjens have served as members of the planning committee of the new Master's degree program in Technology and Policy in the School of Engineering. Professor Pressman served on the prelaw and law-related advisory committees of the Institute. Professors Weiner and Skolnikoff have served on the advisory board of the International Nutrition Planning Program. Professor Pool is director of the research program on communications policy involving the Center for International Studies, the Center for Policy Alternatives, the Electronic Systems Laboratory, and the Center for Advanced Engineering Study. Professor Weiner is the head of an Institute task force to review Institute procedures and policies concerning the use of human subjects in social science research.

Professor Altshuler will be a principal investigator in a multidisciplinary research project entitled "New Perspectives in Urban Transportation," funded by the U.S. Department of Transportation. Members of the Sloan School, the Department of Economics, and the Center for Transportation Studies will take part in this new major research effort.
The Department has also established close links with the new program in Technology Studies. This year Langdon Winner, a political philosopher with a doctorate from the University of California at Berkeley, began a joint appointment as Assistant Professor in Political Science and Technology Studies. Professor Joel R. Yellin in Technology Studies, a lecturer in the Department of Political Science, will teach a new undergraduate subject next year with Professor Skolnikoff on Value, Choice and Risk in Modern Technology, exploring some of the major social effects of twentieth century technology. A similar arrangement has been made with the International Nutrition Program (I. N. P.). Professor Levinson of I. N. P. is now teaching a subject in Political Science as part of a new graduate field in nutrition planning.

Among the other varied research projects currently under way in the Department, some of which were initiated this year, mention should be given to the work of Professor Douglas A. Hibbs on the comparative study of labor conflict in industrial societies; rural out-migration and urban growth in Mexico by Professor Cornelius; a project under Professor Berger on the role of social science research in public policy; Professor Pressman and Dr. Louis Menand on Congressional control of the Central Intelligence Agency; Professor Choucri on resource constraints for the United States; and two studies nearing completion: Professor Griffith on German policy toward the East, and Professor Lipsky on the politics of street-level bureaucracy.

Public Service Activities

Both in teaching and research, the Department has always had a major concern with issues of domestic and foreign policy. This concern also has been reflected in the wide range of faculty activity outside the Institute. This year several members of the Department, including Professors William W. Kaufmann, Pool, Bloomfield, Rathjens, and Greenwood, have served as consultants and prepared studies on arms control and defense policy for the Arms Control and Disarmament Agency and for the Departments of Defense and State. Three faculty members, Professors Griffith, Berger, and Weiner, prepared studies for the Rockefeller Commission on Critical Choices for Americans. Professor Griffith is the director of the Soviet-East European Panel of the Commission, while Professors Berger and Weiner serve, respectively, on the European and Asian Panels.

In domestic affairs, Professor Altshuler continued to be involved in a variety of public service activities involving urban transportation policy. Professor Johnson engaged in a number of activities which concerned improving educational opportunities for blacks in America -- with the Ford Foundation, the American Political Science Association's Committee on the Status of Blacks in the Profession, and at Howard University.

Several faculty members have been concerned with the developing countries. Professor Cornelius studied urban policy in Latin America for the Social Development Division of the United Nations. Professor Choucri participated in the Tribune of the World Population Conference in Bucharest, Rumania, and has been working with the Population Council, Inc. on population policies in developing countries. This year Professor Weiner completed his work as chairman of the National Academy of Sciences Committee on population policies of developing countries; the report of that committee, *In Search of Population Policy*, has been circulated widely by the Academy in English and Spanish editions. As a member of a study commission for Senator Edward Kennedy, and as a consultant to the Department of State and to the U.S. Senate, Professor Skolnikoff has been examining United States food policy for developing countries. Professor Pye continues to be involved in issues of American policy toward China. He remained vice president of the National Committee on
School of Humanities and Social Science

U.S./China Relations, and early this year returned to China as an advisor to Senator Henry Jackson.

Faculty

New Appointments

We are particularly pleased to welcome the return of Professor Altshuler who served for the past three and one-half years as Massachusetts Secretary of Transportation and Construction; he holds a joint appointment with the Department of Urban Studies and Planning.

Joining the Department next year as an Assistant Professor will be Professor Lloyd Etheredge from the University of Manitoba, a specialist in political psychology and behavior. Professor Etheredge received a doctorate from Yale University. Charles Langford Jones, a specialist in political analysis, concepts and methods, joins the Department for a year replacing Professor Alker who will be a Visiting Professor at the University of Geneva, and for Professor Hibbs who will be on research leave. Professor Jones is on leave from the University of Edinburgh. Also joining the Department next year, to replace Professor Lipsky who will also be on research leave, is Martha Weinberg, a specialist in urban and state politics who recently completed her doctorate at Harvard University.

Honors, Promotions

The Department was particularly pleased with Professor Pool's appointment to the Arthur and Ruth Sloan Chair of Political Science. Professor Pool is one of the country's leading scholars in the field of public opinion and communications research. He is the author of innumerable articles and books, and presently is studying the social impact of new communications technologies, such as CATV and satellites, and exploring domestic and international policy issues associated with the development of telecommunications. Professor Pool is one of the founders of the Department of Political Science and has served as its chairman. Professor Pressman received an award from the Graduate School Council for excellence in graduate teaching. Professor Isaacs was elected a Fellow of the American Academy of Arts and Sciences. Associate Professors Berger and Lipsky have been promoted to full Professor; Professor Choucri has been granted tenure, and Assistant Professor Pressman has been made Associate Professor. Professor Berger has been elected Associate Chairman of the Faculty, beginning July, 1975.

Members of the Department also have received a variety of awards and grants this year, from the National Science Foundation, the Smithsonian Institution, the National Institute of Child Health and Human Development, the Rockefeller and Ford foundations, the Kettering Foundation, the Markel Foundation, the North Atlantic Treaty Organization, and the Social Science Research Council.

MYRON WEINER
A useful rule has it that departments and laboratories, no matter how successful they deem themselves, should attempt new starts at intervals of at least five years. By such a count, the year under review deserved to be as special as it seems to us now: It marked the tenth year since psychology was launched, in 1964, as a regular department at M.I.T., and the fifth since the beginning of a particularly integrated program in the behavioral and neural sciences.

By 1969, the pattern of staffing had been essentially set, and the Departmental faculty had intensified its concentration in the three selected but overlapping fields of work on 1) relationships between brain and behavior, 2) perception and perceptual-motor learning, and 3) human language and logic (and their early development in the normal child). These areas had been chosen because of converging individual commitments, and, even more, because of a shared conviction that they were ready for discoveries; the past years, including the last, have borne out this expectation.

Yet these commitments also have meant that the Department had to set up and maintain increasingly costly laboratories to cover disciplines that, in more traditional settings, would never have come together under a single roof: laboratories of neuroanatomy and neurophysiology, including multiple facilities for computer-assisted recordings from individual nerve cells within the brain during ongoing behavior; clinical settings for the study of effects of brain injury in man and child; facilities for long-term observations of animal perception and action, especially during and after unusual environmental exposure; laboratories for analysis of human perceptual adaptation, shape, depth and color vision, gravity sensing, and rapid memorizing of visual and auditory displays; and, lastly, facilities for studies of speech comprehension and speech production in adults and children, and for studies of the beginnings of concept formation and sensitivity to norms in the very young.

All of these activities have prospered in the last year, in the hands of an exceedingly small faculty of only 14 with 25 graduate students and seven research associates, together with 13 postdoctoral and other visiting investigators. Accounts of this work appeared in the many publications issued by the Department since June, 1974. However, in the course of the past year, many of these activities found a new focus when a majority of the departmental faculty banded together to launch a new program in which much of their work could be combined: The group requested, and happily obtained, a generous (if still short-term) program award from the National Institute of Neurologic Diseases to support the first three years of intensive investigations of neural plasticity; that is, the growing evidence that the brain, as the organ of behavior, is not altogether fixed but continually modifies itself -- at times even readjusting some of its connections, either after drastic environmental changes or following injury, particularly in early life.

Such concepts of plasticity, though crucial for the age-old problems of recovery from brain injury or disease, are still too little explored and quite controversial. Yet positive proof of plastic rearrangements of neural structure would go a long way towards providing a possible basis for an understanding of memory and learning. Because of its very nature, the work will have to range from the minutiae of radiochemical study of nerve tissues to observations on the
recognition of lines and sound patterns by normal and abnormal infants. Though still insufficiently funded, these basic studies are beginning to attract private grants in addition to the Federal core support that has just been received. Foremost among these subventions in the year under review were an almost unhoped-for renewal of support from the Sloan Foundation and a continuation of subsidies for work on brain mechanisms in early development and learning from the Grant and Spencer Foundations.

The Department is profoundly grateful for all this timely help. Such funds assume even greater significance in the face of the nationwide curtailment of graduate training grants from Federal sources. Both types of awards, Federal training grants and general program support from private groups, permit an equitable distribution of graduate students across laboratories and among younger and older faculty members, both within the Department and beyond, and into the cooperating laboratories in the Departments of Nutrition and Food Science, Biology, Electrical Engineering and Computer Science, and Foreign Literatures and Linguistics. Throughout the Department of Psychology, such shared funds enable us to maintain and extend a common core of radically interdisciplinary work which would be most difficult to support through purely individual efforts.

It must be apparent that the formulation of new programs was in the foreground of last year's activities. At the same time, however, a second potential "new start" came under discussion (in spite of a temporary setback, which will have to be described): For the first time in the Department's short history, serious consideration was given to the possible institution of an undergraduate major. The reasons in favor of such a move seem plain. For most of the last five years, the Department annually has taught over 1,000 undergraduates, and at times as many as 1,500. Admittedly, a majority of these undergraduates in any given semester was to be found in the large introductory subjects taught by the Department Head with the help of the second-year graduate students. Yet beyond that, our undergraduates evidently desired a systematic continuation of their psychology training, since more than 40 were enrolled last year in a psychology "concentration" program within the humanities and social sciences.

Considering such student interest, and the extent of the already existing commitment to undergraduate education, the introduction of an undergraduate major, or possibly several majors, in parallel with the three principal tracks of the Department's graduate and research program, would seem a logical step, although the first ten years of departmental activities had been formally limited to doctoral and postdoctoral work.

On the negative side of the question, however, are a number of issues that were carefully explored by the Visiting Committee during spring, 1975. It is evident to all that the present small faculty, with their available facilities, cannot possibly carry a regular undergraduate program without the addition of more faculty and research space. After all, a course like ours at M.I.T. demands that its undergraduates have free access to laboratory space, and that the faculty have the time to provide appropriate individual guidance to all its undergraduates. Given the degree of existing overcommitment of our present faculty, a move towards an undergraduate major was therefore considered fraught with dangers for the integrity and caliber of the ongoing work.

*According to the rules governing such federally sponsored center grants, an outside consulting group has been appointed for this program, including Professors John Dowlin, David Hubel and Seymour Kety from Harvard, as well as Professors Irving T. Diamond from Duke University, Edward Evarts from the National Institutes of Health, Eric Kandel from Columbia University, and Vernon B. Mountcastle from Johns Hopkins University.
The exploratory discussions would have continued nevertheless, had it not been for a sudden complication that arose toward the end of the year from an unexpected direction. An interdepartment committee, appointed to scrutinize all of the potential undergraduate "electives" in the humanities, arts, and social sciences, took note, as they had to, of the unorthodox nature of the tripartite departmental program, and decided that altogether six of the Department's present 18 undergraduate offerings should no longer be admitted as electives in the humanities or social sciences. Among the subjects thus reclassified as not pertinent as electives was the introductory subject, 9.00, which encompasses the basic principles of all three areas of the Departmental program, and therefore had been set by the Department as prerequisite to all subsequent subjects in psychology. Similarly excluded were an undergraduate subject on animal behavior and a basic introduction to the study of perception. As can be expected from all that has been said before, the Department finds itself in total disagreement with these actions. Seen from afar, these matters might appear as purely jurisdictional, but they involve, in our view, at least three nontrivial issues ranging from the unity of our Departmental program to the question of where, within the overall structure of M.I.T., an admittedly scientific approach to psychology belongs. Thirdly, and much more importantly, there is the question of whether the Institute should not deliberately foster those subjects that cut across conventional divisions between the natural and the social sciences and that reach beyond either or both into the humanities. We believe that the Institute should stress such integrative subjects for the very sake of a strong role for the humanities in a scientific and technical culture.

Though unforeseen, it is no accident that psychology should become an issue in this context. Our approach compels us to look at human behavior, simultaneously and necessarily, as part of nature and as a product of culture. For that reason, psychology contributes the more to inquiries into human nature the more effectively it resists both internal and external strains toward subdivision. We can serve either as an administrative perplexity or as a type-case for the unity of culture. As we said recently elsewhere, we seem to live on top of a fault that cuts across our Institute or, more fairly put perhaps, across much of our contemporary education. Yet such faults can now be approached with reason, and ultimately cured. We realize that a resolution of these issues will take much time and thought in the year to come; despite its abrupt emergence, the problem has obviously been latently present for the last ten years, and characterizes the paradoxical position of psychology in other institutions as well. Yet we are confident that the issues will be resolved within the framework of the Institute's overall educational policies, thus permitting us to develop a clearer perspective of the functions of our field in M.I.T.'s undergraduate program.

It remains for us to give some brief additional indications of last year's teaching activities and of certain special accomplishments in these and other respects. During 1974-75, 1,384 students were enrolled in the 18 undergraduate subjects offered by the Department; an additional 180 students, for a total of 1,564, distributed themselves over the 18 graduate subjects, from the "proseminar" required of all first-year doctoral students to various more advanced seminars. Several of these were offered jointly with other divisions or departments, such as Introduction to the Human Nervous System (Institute Professor Walle Nauta, with Professors Emilio Bizzi and Ann M. Graybiel), which was given within the framework of the joint Harvard-M.I.T. Program in Health Sciences and Technology (H.S.T.); the intensive seminar on sensorimotor processes (Professors Laurence R. Young, Richard M. Held, and Bizzi); which was offered in cooperation with the Department of Aeronautics and Astronautics, and the special seminar in Cognitive Development (Professor Susan Carey) which was held jointly with the Division for Study and Research in Education.

The slight drop in undergraduate enrollment in 1974-75 against 1973-74 can be attributed to an anomaly in 1973-74, when Professor Hans-Lukas Teuber, as usual, not only taught the introductory subject, 9.00, in both fall and spring semesters, but also a newly organized subject, 9.60, in spring, 1974. In 1974-75, however, 9.00 was offered only in the fall; and was attended
by 470 students. In spring, 1975, Professor Teuber taught a modified subject, 9.60, which served, in effect, as a continuation of 9.00, accommodating more of the sociocultural subjects, though not exclusively so, as well as essential features of human language, abnormal behavior, and early development. On these last three subjects, supplemental guest lectures were provided by Professors Noam Chomsky of the Department of Foreign Literatures and Linguistics, Stephan L. Chorover, and Susan Carey. The new version of 9.60 was attended by 458 students.

In the coming year, 1975-76, our introductory subjects 9.00 and 9.60 will be cancelled to permit further deliberations about their role. In the spring term, 1976, a new subject, 9.61 will be introduced which will recombine the more biologically oriented material from 9.00 with the more socioculturally oriented material of 9.60, thereby returning to an earlier version of 9.00.

As to the other 16 undergraduate subjects, where enrollments ranged from over 80 to just a few, and, appropriately so, in advanced undergraduate seminars and workshops, only those will be mentioned that represent new offerings, or major revisions of previous ones, and the same will be done with graduate subjects. These new or reorganized sequences include Professor Graybiel's novel seminar series on brain and behavior (with occasional guest lecturers such as Professors Bryan Boycott and David Hubel); Professor Chorover's new subject on "psychotechnology" -- the ethical issues raised by psychometric testing and by psychologic attempts at manipulating individuals and groups; the closely related new subject offered by Professor Carey and her husband Professor Ned Block, of the Department of Philosophy, which dealt with I.Q., heredity, and human equality. We also should note a special undergraduate introduction to sensory neurophysiology by Professor Peter H. Schiller; Professor Mary C. Potter's new sequence on learning; Professor Alan Hein's and Dr. Rhea Diamond Gendzier's undergraduate seminar on origins of behavior; Professor Whitman A. Richard's advanced seminar on space perception; and the year-round work sessions in psycholinguistics conducted by Professors Jerry A. Fodor and Merrill F. Garrett.

In addition to all of these offerings, together with those from previous years, there were the numerous informal research conferences in the individual laboratories as well as the regular departmental colloquia, given primarily by outside speakers, which this year numbered 53, covering topics in the three areas of the Department's concern; 20 of these speakers came to us from abroad.

We have mentioned all of these teaching efforts, some old and some new, in all their diversity, in order to make two points: to depict, once again, the wide reach of departmental endeavors across fields, and to underline the obvious fact already stressed in previous reports that our small faculty of 14 (of whom three are shared with other divisions or departments), continues to be hopelessly overburdened; teaching as they did, 1,564 students this year while conducting 26 separate research projects or programs, participating in U.S. and foreign meetings, giving invited outside lectures, and serving on Institute or on national and international committees and boards.

On these last points, a full listing would be impossible, but we should mention, at the risk of making arbitrary selections, that in spring, 1975, three of our graduate students, Susan Leehey, Helen Sherk, and Michael Stryker, received special awards from the National Eye Institute for research reports submitted to the Vision Meetings in Sarasota. Moreover, Institute Professor Nauta, besides other honors and burdens, began service as chairman of the Executive Council of the International Brain Research Organization (a position held previously by another department member), and, in early June, received an honorary doctorate from the University of Rochester. Professor Held, in addition to many other distinctions and self-imposed chores, ran a singularly successful meeting during the Independent Activities Period in January, 1975, on Vision, Art, and Science, with participation from the Institute and
from Columbia, Harvard and Yale universities, and the University of Pennsylvania. This meeting was the third annual conference of that kind held within the Department, and the first to be co-sponsored by the Council for the Arts at M.I.T.

Lastly, Professor Garrett returned from a year's leave under the Fulbright-Hays Exchange Program as Senior Scholar at Monash University, Melbourne, Australia, having held invited colloquia at the Universities of St. Andrews, Scotland, and of Sussex, England. Professors Graybiel and Nauta both participated in the Symposium on Axonal Transport in Gwatt, Switzerland; Professor Gerald E. Schneider gave invited papers at the Universities of Lausanne, Edinburgh, and Bristol, as well as at the Brain Research Institute in Zurich. Both he and Professor Bizzi also gave talks at the University of Freiburg, Germany. Professor Bizzi gave a paper at the Medical School of the University of Göteborg, Sweden, attended an eye movement control meeting in Stockholm, and lectured at the National Center for Scientific Research in Paris, and at the University of Genova, Italy. Professor Hein gave a colloquium at Dalhousie University in Halifax, and Professor Fodor lectured at the University of Alberta, Edmonton, and at McGill University in Montreal.

Professor Teuber gave the 1974 Christmas Lecture in Chicago, sponsored by the Illinois Science Lecturers Association. He also gave the annual Children's Lecture at M.I.T. where he spoke on "Visual Illusions." In April and early June, 1975, he traveled twice to Europe to give inaugural lectures and receive honorary doctorates, one from the Medical Faculty ("Claude Bernard") at the University of Lyon, France, and the other in psychology at the University of Geneva, Switzerland. That second ceremony was held on the triple occasion of the opening of a new University building in Geneva, the change in the status of psychology there to that of an independent "faculty," and the naming of the new auditorium in honor of the founder of Geneva's School of Developmental Psychology, Professor Jean Piaget.

HANS-LUKAS TEUBER
This year's summary of the Sloan School's teaching and research activities continues to reflect the School's strong interest in combining innovation and excellence in management education and the conduct of pure and applied research in related disciplines or functional fields. It reflects as well the School's efforts to seek knowledge in less well defined and multidisciplinary domains and to strive for longer term impact on important management issues which impinge on vital questions of the times.

Teaching Programs

Undergraduate Program

The majority of students in our undergraduate degree program continue to choose the special programs and management science options, but both the behavioral science and system dynamics options have begun to attract a growing number of interested students. The experimental Undergraduate Studies Program, initiated several years ago by Professor Jay W. Forrester, and more recently administered by Professor Leo B. Moore, was formally ended this year. Several objectives of the experiment, notably the opportunity to plan and execute special projects, have been incorporated in other ongoing programs of the School. Although the number of students enrolled for the degree in our undergraduate program declined slightly in the 1974-75 academic year (from about 130 to about 120), a large and growing number of engineering and science undergraduates continue to elect management subjects.

An Undergraduate Student Advisory Council, organized for the first time this year, proved to be an effective means to identify problems of undergraduates, to generate suggestions for solving them, and, through the use of student resources, to implement certain changes. Six undergraduates devoted many hours to this work, and we anticipate that the number of students participating in an advisory role in the School will increase in the future, both through membership on the Student Advisory Council and through its allied activities.

Our participation in M.I.T.'s Undergraduate Research Opportunities Program (UROP) remains substantial; Professor Stuart E. Madnick has continued as UROP coordinator for the Sloan School. The success of this Institute-initiated program, which provides an opportunity for undergraduates to engage in projects professionally with a wide variety of faculty, was a significant factor in our decision to terminate the Undergraduate Studies Program option in our array of possible routes to the Bachelor of Science degree in Management.

Senior Lecturer Stanley M. Jacks and Administrative Assistant Esther Merrill again served, respectively, as chairman and program coordinator of the undergraduate program and will continue to serve in these capacities during 1975-76. They and our Undergraduate Program Committee members and counselors, Professors Madnick, Thomas J. Allen, Roy E. Marsten, Gary L. Lilien, and James M. Lyneis, have continued to work on reviewing the undergraduate program, and to give effective individual counseling to undergraduates despite many other calls on their professional time.
Master's Programs

In 1974-75 we continued to offer accelerated (12-month) and regular (two-year) programs leading to the degree of Master of Science in Management, with 1975 graduating classes of 35 and 103, respectively. Core requirements are essentially the same in both programs.

On the basis of three years' experience, we have concluded that the accelerated program is highly effective and efficient in meeting the needs of relatively mature students (at least one year of full-time work experience is prerequisite to admission) in preparing for the assumption of general management responsibilities. Perhaps because of unwillingness to abandon secure positions under conditions of economic uncertainty, applications for June, 1975, admission increased only slightly from the previous year, and the total of 133 remains insufficient for program expansion without loss of quality. We believe that a much larger market for this service exists than has yet been reached and are prepared to consider expansion of our admissions to two sections when the constraints of physical plant and a currently weak economy permit us to tap that potentially higher demand.

For the purposes of those interested in developing exceptional competence in one or another management-related specialty, the two-year program, affording as it does more time for elective subjects and greater flexibility in scheduling, is clearly preferable. We are currently evaluating the demand for such broad-based "specialists" and, should it prove to be as substantial as we expect, may hereafter recruit for the two-year program largely on this basis. If so, the 12-month and two-year routes to the S. M. in Management will thus be more clearly differentiated, not only from each other but also from programs of management study in other universities.

In total, applications for 1975 reached an all-time high of 854, with increases over the previous year of seven percent in foreign and 18 percent in domestic applicants. The number of applications from women, which rose by 43 percent in 1974, increased again (by 66 percent) to 167, approximately 20 percent of all received. In contrast, apparently in common with most other schools of management, we experienced no appreciable growth in the number of minority applicants. It is our intention to devote more effort to minority recruitment during the coming year, but insofar as financial support may be a critical factor, it may be difficult to attain dramatic improvement.

The following data are descriptive of the Class of 1976, including entrants to the two-year program (T. Y. P.) in September, 1974, and to the 12-month program (A. G. P.) in June, 1975.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>A. G. P.</th>
<th>T. Y. P.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex: Female/Male</td>
<td>7/22</td>
<td>22/66</td>
</tr>
<tr>
<td>Age: Median/Range</td>
<td>28/23-34</td>
<td>24/19-46</td>
</tr>
<tr>
<td>Married/Single</td>
<td>19/10</td>
<td>29/59</td>
</tr>
<tr>
<td>With Full-Time Work Experience</td>
<td>29</td>
<td>5</td>
</tr>
<tr>
<td>From: Countries/States</td>
<td>6/9</td>
<td>19/16</td>
</tr>
<tr>
<td>Mean Undergraduate Grade Point Average*</td>
<td>3.9</td>
<td>4.3</td>
</tr>
<tr>
<td>Median Admission Test Score**</td>
<td>655</td>
<td>607</td>
</tr>
</tbody>
</table>

* On 5.0 scale excluding some foreign students
** National average is approximately 460

Preliminary placement data on the Class of 1975 indicate an overall increase in average starting salary of about 7.5 percent, the means of average salaries reported to date being $20,600 for the accelerated program and $18,700 for others. Fewer persons have accepted
Teaching Programs

jobs in manufacturing than in 1974; more have entered both financial institutions and business services (including consulting).

Doctoral Program

The purpose of the Sloan School’s doctoral program is to prepare students for careers in either teaching or research, or for nonacademic positions requiring advanced research and analytical capabilities. The demand for graduates of the program continues to be strong, with most of the Ph.D. recipients accepting positions either with universities or with research organizations. This year, graduates went to Columbia University, M.I.T. Sloan School of Management, University of Southern California, Georgetown University, IBM’s Thomas J. Watson Research Center, and the Continental Oil Company.

The program continues to attract a large number of excellent applicants, both from the United States and abroad. This year, 27 were accepted from a pool of 166 applicants. Fifteen students entered the program, specializing in the following areas: Management Science, 5; Finance, 4; Organization Studies, 3; International Management, 1; Industrial Relations, 1; and Policy, 1.

This was the first year under the recent changes in examination scheduling. While it is too early to evaluate fully the long-term effects of the new arrangements, everything ran quite smoothly during the first year of their implementation.

The chief difficulty in the program is financial. Students caught between rising costs and dwindling sources of support are facing increasingly severe financial pressures. If the program is to continue to attract high quality candidates, we will have to develop new sources of support for our doctoral students.

The Doctoral Program Committee chairmanship was assumed by Professor Allen this year. At the same time, Christine Kane took over from Kathryn Scott as coordinator of the program.

Alfred P. Sloan Fellows Program

On June 2, 1975, 50 members of the 37th class of Alfred P. Sloan Fellows received the degree of Master of Science in Management. As is typical of this unique program, the entering class represented a series of firsts: the largest number of women (six), the largest group interested in the management of educational institutions (three), and a number of organizations represented in the program for the first time (see below). The Class of 1975 was also the first class of Sloan Fellows to visit Iran, as part of their Foreign Management Field Trip.

The Class of 1975 included representatives of 13 organizations participating for the first time in the program. These organizations were A/S Norske Esso; Baykov Institute of Metallurgy USSR; Christiana Hundred; Community Metropolitan Planning Project; Fluor Corporation; George Madsen Construction Company; Pullman Incorporated; Signatron Incorporated; Sherborne School; Syms, Incorporated; the U.S. Department of Agriculture; the U.S. Department of the Treasury; and the U.S. Department of Transportation.

The composition of the 1976 class continues to reflect the growing interest in the study of management on the part of different elements of our society and from abroad. The study of
management, pioneered by senior executives of industry and then the Federal government, is in increasing demand by those who must manage cities, universities, medical services, and so on. A recent survey of the last seven years' classes of Sloan Fellows indicated that 90 percent of those from the private sector felt that studying alongside managers from the public sector added considerably to the richness of their experiences at M.I.T. More than 80 percent of the public executives felt the same about their private sector counterparts.

In this year's class of 50 Sloan Fellows, 33 were from private industry, 12 from government agencies, and five from a miscellany of nonprofit, nongovernmental organizations. Comparable data for the 1970-71 class reflect this changing mix in private and public sector program participants. There were a total of 47 Sloan Fellows, with 39 from private industry, four from government agencies, and four from nonprofit organizations.

The Sloan Fellows Program continues as one of the most prominent executive development programs around the world, and we continue to be proud of its successes, of the effective direction given to this program by Dr. Peter P. Gil, Associate Dean for Teaching Programs and Senior Lecturer, and of the contributions to its administration by his staff.

**Health Management Executive Development Program**

A major new educational activity of the past year has been the development and announcement of a 12-month Health Management Executive Development Program. Aimed at midcareer to senior level health care practitioners, educators, researchers, and administrators, the program seeks to provide doctors, nurses, and health administrators an intensive management development experience in preparation for continued career growth and increased responsibility in health-related areas. Working within the framework of the Sloan Fellows Program, the new program combines general management education with specific subjects in health management issues and organizations.

For the first class beginning in June, 1975, six candidates were accepted as health-related Sloan Fellows, including one public health administrator, two nurse administrators, and three doctors from academic medical centers. We plan to admit 10 to 12 health professionals in the 1976-77 class.

**M.I.T. Program for Senior Executives**

The 38th and 39th programs were offered in 1974-75. Demand has been very strong for spaces, both from U.S. industry and the Federal government as well as from countries throughout the world. A number of companies and organizations have ongoing reservations for spaces in the program. The wide variety of national backgrounds represented in the program is impressive. In keeping with the international character of the program, the curriculum offers a number of topics and seminars of interest to multinational executives.

The program offers a self-study option for each of the participants. Each senior executive is invited to pursue an area of special interest while at the Sloan School, often with the tutorial or consultative assistance of faculty.

Professor Arnoldo C. Hax served as chairman of the program's faculty committee; Alan F. White, an M.I.T. alumnus (Sloan Fellow at M.I.T. in the Class of 1970-71), continued as the program director.
Teaching Programs

The age range of senior executives in both the fall, 1974, and spring, 1975, programs continued to be 40 to 50 years. The average participant is in the mid-40s. Typically, 10 to 12 foreign senior executives are represented in classes whose enrollment is 28 or 29 participants in each session.

M.I.T. Program for Urban Executives, June, 1975

The eighth M.I.T. Program for Urban Executives was held at Endicott House and the Sloan School from June 1 to June 27, 1975. Part of the teaching load was carried by faculty from the Departments of Urban Studies and Planning and Civil Engineering.

Twenty-one participants from the United States and Canada attended the program. Participants were city and town managers, department heads, and other career managers. One of the most encouraging signs is that cities represented in earlier programs continue to make nominations on a regular, continuing basis.

We continue to enjoy and appreciate the support of the following organizations: the National League of Cities, the United States Conference of Mayors, the American Society for Public Administration, and the International City Managers Association. Mr. White is the program director for this effort as well as for the Program for Senior Executives.

Greater Boston Executive Program

The Eighteenth Session of the Greater Boston Executive Program (G.B.E.P.) was held from January 24 to May 2, 1975. Continuing with the decision to limit the number of participants to increase interaction among them, this year's class numbered 18. Ten organizations were represented in the program.

This 15-week, one-day-a-week program continues to receive very positive reception from the Greater Boston companies who participate, as well as continued appreciation from its alumni. The 1975 G.B.E.P. Alumni Reunion was well attended by alumni and their spouses.

Summer Programs

Members of the Sloan School faculty offered ten special programs during the summer, 1974.

Professors Stewart C. Myers and Richard A. Cohn, assisted by Professor Gerald A. Pogue of Baruch College, the City University of New York, offered two consecutive one-week programs for managers with interests or responsibilities in corporate financial management and planning. The first, Basic Concepts in Financial Management and Strategy, considered capital budgeting decisions, cost of capital, dividend policy, acquisitions and mergers, and methods of measuring the performance of a firm's pension fund. The second, Models for Financial Management and Long-Range Financial Planning, dealt with the design and application of financial models. Participants were given experience in the use of time-shared computer based models and worked with time-shared models for solving a realistic short-term financing problem, designing an optimal banking system for an organization and applying
linear programming to problems of capital budgeting and long-term financial planning. In addition, there was extensive discussion of simulation models for budgeting and planning and of the design and implementation of financial information systems.

Advanced Software Engineering Focusing on Operating and Real-Time Systems, a two-week program, was conducted by Professors Madnick and John J. Donovan. This program presented a view of advanced computer software systems, particularly operating systems, based upon the management of resources. Emphasis was placed upon separating issues of "mechanisms" from issues of policy. Key resources (memory, processors, devices, and information) were identified and explained, and models were developed for purposes of system design as well as performance evaluation.

Long Range Planning Systems: Approaches and Developing Issues was a one-week educational program designed to satisfy the needs of the senior line managers and staff planners of both profit and nonprofit organizations. Part I dealt with concepts and approaches, and Part II was devoted to a critical evaluation of the current state of the art in planning. The program followed a lecture-discussion format, supplemented by case analyses where appropriate. Parallel sessions were held for all cases, one devoted to a problem situation relevant to a profit-oriented firm and the other to a nonprofit organization. Faculty members for the program were Dr. John F. Rockart, Professors Peter Lorange, Peter G.W. Keen, Michael S. Scott Morton, and Jerry D. Dermer.

Management Science in Marketing: Decision Support for Marketing Management was directed by Professor Alvin J. Silk. This was an applied program oriented toward the needs and interests of marketing management and staff personnel. It was designed to demonstrate by case studies and "hands-on" workshops the benefits and limitations for marketing decision making of model-based information systems and modern measurement techniques. The first three days of the program focused on concepts, methods, and issues of general applicability. Then the program offered marketing topics. Guest lecturers in the program were Professors Lilien, John D.C. Little, Glen L. Urban of the Sloan School; Professor Jerome D. Herniter of Boston University; and Dr. Sidney Schoeffler, Visiting Senior Research Fellow, Harvard Business School.

Professor Forrester again presented Systems Dynamics, Methodology and Applications; Emphasis on Industrial, World, Urban, and National Issues. Lectures presented the fundamental principles and methodology underlying the study of multiple-loop feedback systems. Case studies illustrated issues in problem definition, model building, analysis, and policy design, and provided examples of applications. Workshops were held in the areas of urban behavior, world evolution, industrial policy, and economic issues. Assisting Professor Forrester in the development and conduct of the program were Professors John F. Collins and John Henize; Division of Sponsored Research staff members, Louis E. Alfeld, Walter W. Schroeder III, and Peter Senge; Research Associates Kenneth R. Britting and Alexander L. Pugh III; Lecturer Richard Wright, and other members of the Systems Dynamics Group in the Sloan School.

Professor Edgar H. Schein and Senior Lecturer Richard Beckhard also repeated the one-week "live-in" program, New Horizons in the Management of Change and Organizational Development, at Endicott House in Dedham. The issues discussed included organization development and planned change in an increasingly turbulent economic, political, and social climate; organization structure and design in the multiproduct, multimarket, multinational corporation; and corporate responsibility in an increasingly complex society, involving issues such as pollution, involvement in urban affairs, product safety, minority group employment, and employment of women.
Teaching Programs

Professor Edward B. Roberts will lead the two summer programs that he has given in previous summers. In June the two-week program, Management of Research, Development, and Technology-Based Innovation, was offered. Program content was based on two general disciplines: behavioral science concepts that are applicable to the organization and management of individual scientists and engineers, technical groups, projects, and research and development laboratories; and organizational systems analysis and design concepts applicable to the planning, selection, resource allocation, and control aspects of technology-oriented programs. Other faculty collaborating with Professor Roberts were Professors Allen, George F. Farris, and Eric von Hippel. Visiting lecturers included Professor Herbert Hollomon, Director of the M.I.T. Center for Policy Alternatives; Professor Paul Lawrence of the Harvard Business School; Dr. Marvin J. Cetron, President of Forecasting International, Ltd.; and Dr. Alan L. Frohman of Pugh-Roberts Associates, Inc.

In July, Professor Roberts offered the one-week program, The Dynamics of Health Service Systems. The program aimed at reporting progress to date in the application of systems analytic methods to health care delivery, and at stimulating new attacks on the problems of health service systems. Morning lectures were followed by afternoon sessions where staff members assisted the participants in developing simulation models of simplified health care systems and in experimenting with their models by use of an interactive time-shared computer capability. Working with Professor Roberts were Dr. Jerome Grossman of the Harvard Medical School; Professor Gilbert Levin of the Albert Einstein College of Medicine; Dr. James Potchen, Dean for Management Resources of Johns Hopkins Medical School; Dr. Stanley B. Troup, Vice President for Health Affairs of the University of Cincinnati; Dr. Leon S. White, Commissioner of Health and Hospitals of Boston; Mr. Pugh and Dr. Wright of the System Dynamics Group of the Sloan School; and Gary Hirsch of Pugh-Roberts Associates, Inc.

Finally, Professor J. Daniel Nyhart, who holds joint appointments in the Alfred P. Sloan School of Management and the Department of Ocean Engineering, also presented a one-week summer session, Ocean Resources Management, Legal and Policy Aspects. The program was presented in cooperation with the M.I.T. Sea Grant Program and was intended for policy level executives, engineer-managers with operating program responsibility, project engineers, or corporate legal counsel in business or financial firms; for lawyers in private practice who desired to extend their knowledge of the latest developments in the field of ocean law and their understanding of related technological developments; and for government officers concerned with ocean or coastal zone policy. Topics included international conventions and treaties relating to the law of the sea; U.S. domestic regulations pertaining to the sea; living and nonliving resources of the sea; maintaining the ocean environment; and legal and policy aspects of offshore oil and gas, offshore energy generation, hard mineral mining, and deep water ports. Professor Nyhart was assisted in the presentation of the program by Professor R.R. Baxter of the Harvard Law School and Professor Judith T. Kildow of the Department of Ocean Engineering and M.I.T. Center for Policy Alternatives.

Once again, these special summer programs helped provide valuable post-experience training for a wide variety of managers in both private and public or nonprofit organizations. In these special programs, we again drew participants from around the world.

Industrial Liaison Symposia

In late April Professor Nyhart presented a symposium, Offshore Installations: Legal, Technical, Policy Considerations. This session reviewed and examined current and recent research at M.I.T. in the technical, legal, and policy aspects of a wide number of offshore activities involving industry, including offshore oil and gas exploitation, hard mineral mining
on the continental shelf and beyond, offshore nuclear power plants, management of the coastal zone, deep water ports, multipurpose offshore platforms, and artificial islands for multiple energy uses.

Research

The School's program curricula rest in large part upon the research activities of our faculty, staff, and students. This section summarizes some of these varied activities and accomplishments.

Human Factors in Management

The faculty in our Organization Studies Group in our Manpower and Labor Relations Group take as their primary focus the role of human factors in management and policy issues. The social and behavioral sciences -- psychology, sociology, economics, and so on -- are the disciplinary bases upon which much of this research is built.

Organization Studies

Several members of the faculty continue to focus on the problems of adult socialization, career development, and the interaction of work, self, and family issues throughout the life cycle of men and women in different occupations. While work so far has tended to focus on technically based careers, managers, and some urban workers, plans are developing for a broader, comparative, longitudinal approach to a wide range of occupations. The goal is to better understand how such interactions at different life stages lead to patterns of productivity, creativity, job satisfaction, and accommodation among different life concerns. Specific examples of this work are:

1) Professor Lotte Bailyn's continuing study of accommodation patterns in educated adults, especially in dual career families. The differential impact of family and work issues on men and women at different life stages is of particular importance in this research.

2) Professor John Van Maanen's research on the characteristics of different kinds of work settings in different occupations and how these settings produce certain patterns of socialization in new recruits into the occupation, leading ultimately to a general theory of occupational socialization.

3) Professor Ralph Katz's ingenious analysis of job satisfaction as a function of how many years the employee has been on a given job, leading to a much more refined and complex theory of job satisfaction throughout the career.
4) Professor Schein's continued analysis of the 1961 panel study showing that career anchors develop or become manifest early in the career and subsequently serve as constraints on future career decisions. Of research interest are changing value patterns within the panel group as well as within the society, the latter questions being investigated by a readministration to the 1974-75 class of Sloan Fellows of a survey originally done with the 1961 Sloan Fellows.

5) The work of Professors Keen and David A. Kolb on the different cognitive styles of managers and the impact of such style on decision making and career development.

6) Dean Gil and Professor Schein are continuing studies on career paths of Sloan School alumni and are developing methods of analysis which permit the identification of such patterns from career history data.

7) Mr. Beckhard is continuing his survey of mid-career crisis in high potential managers. Working primarily with cases uncovered in relation to his extensive consulting activities, Mr. Beckhard is generating hypotheses concerning the reasons why an increasing number of high potential managers are turning down promotions and leaving organizations in which they have high career potential. Mr. Beckhard and Professor Schein are exploring the value implications of these data in relation to societal value changes.

Various of these projects are reaching the publication stage, with Professors Bailyn and Schein completing a book on the roots and correlates of work involvement in technically based careers. Professor Van Maanen is compiling and editing the text of the symposium on career development sponsored by the Industrial Liaison Program in spring, 1974. Professors Van Maanen and Katz are finishing a monograph on job satisfaction patterns in urban workers; and Professors Van Maanen and Schein are completing an integrative chapter on career development for the volume on the quality of the working life, edited by Professor Richard Hackman of Yale University, and published with the support of the U.S. Department of Labor.

Another area of research within the group is related to the improvement of health care delivery through the design and study of educational interventions, particularly at the management level. The research is discussed in the following section dealing with health care management.

Though the research efforts of individual faculty members continue to be largely guided by the requirements of their own projects and the scientific issues they are trying to address, there is a growing communality of both scientific and practical concerns evident in the group. In particular, we see a growing concern for the development of theory in the art of applying knowledge and translating scientific findings for the practical arena of management. Many of the members of the faculty are actively engaged in planned change and organization development activities, and this applied or clinical group focus continues to be one of the main sources of strength.

These efforts are especially enhanced by the research projects undertaken by Professor Reuben T. Harris and Mr. Beckhard on the effects of different kinds of planned change interventions. Research in this area has been sparse, but a major effort to locate change projects and to measure the effects of different approaches to change is being launched, not only in health care delivery, but in industrial organizations using organization development activities and urban systems attempting to improve urban management. Professor Moore continues to be a source of important case material on projects going on in various companies.
Manpower and Labor Relations

Research in this group centers on the fields of labor-management relations and public policy, manpower and manpower policies (including those affecting minorities and women), international aspects of industrial relations, labor economics, law and labor law, and the management of human resources (personnel administration).

Professor D. Quinn Mills completed his study of wage stabilization policy in the United States, and his book, Government, Labor and Inflation, will be published by the University of Chicago Press in the fall. This work grew in part out of his earlier chairmanship of the Construction Industry Stabilization Committee, and as a key staff member of the Cost of Living Council which administered wage and price controls during 1971-73. Also growing out of this experience was another study; "Some Lessons of Price Control, 1971-73," which was published in the Bell Journal of Economics this spring. In another area, Professor Mills continued his interest in the interface between industrial relations and organizational behavior in a paper, "Managing Human Relations Among Organizations," for Organizational Dynamics (a publication of the American Management Association). Finally, supported by a grant from the U.S. Department of Labor, Professor Mills concluded his work on the application of computer technology to the construction industry labor market.

Professor Phyllis A. Wallace completed the manuscript of a book she edited and for which she wrote several key chapters on "New Perspectives on Equal Employment Opportunity: The AT&T Case." This will be published by the M.I.T. Press in fall, 1975. A final publication containing papers and proceedings from the research workshops held under the direction of Professor Wallace, supported by a grant from the National Science Foundation, is in progress. She is also working on a monograph on the employment status of black women and has begun a study on the upward mobility of women in management, principally in a large New England company. Professor Wallace presented a joint paper on "Public Policy and Black Economic Progress" at the December, 1974, annual meeting of the American Economic Association, and another on "A Decade of Policy Developments in Equal Opportunities in Employment and Housing" at a conference in February, 1975.

Professors Mills and Wallace, along with Professors Charles A. Myers and Michael J. Piore (a member of our group from the Department of Economics), supervised graduate student research in the initial year of a three-year study of decentralized manpower programs under the Comprehensive Employment and Training Act of 1973 (CETA). This study is supported by a three-year research contract from the Office of Research and Development, Manpower Administration, U.S. Department of Labor. Five graduate students began field research last September in Cambridge, Lowell, Newton, Quincy, and at the State Office of Manpower Affairs. Their theses and separate reports were submitted in May, as another group of graduate students prepared to follow them in the same areas (and in some new areas) during the summer and the academic year. In May, the first student research group made an oral report to Federal officials in Washington on the first year's studies. An additional subcontract in our contract, coordinated with our research, covers the City of Boston study under the direction of colleagues in the Department of Economics at Northeastern University.

A previous Manpower Administration research contract for studies of "Labor Market Information Systems and the Disadvantaged" was completed last September, with a final report written by Professor Myers. An additional report is being completed by Professor James E. Annable, Jr., who joined the staff of the Federal Reserve Board in September, 1974.

In the international area, Professor Kenneth S. Mericle has completed a study of the role of multinational corporations in the Brazilian motor vehicle industry, with particular reference to the problem of "employment transfer." This is part of the International Business Project,
Research

and the study was supported by a grant from the U.S. Department of Labor. Professor Mericle is revising his study of some aspects of the Brazilian system of industrial relations for possible publication.

Also in the international area, Professor Myers was co-author, with John T. Dunlop, Frederick H. Harbison, and Clark Kerr, of a final report on a 22-year, inter-university research project recently published at Princeton under the title: Industrialism and Industrial Man Reconsidered: Some Perspectives on a Study over Two Decades of the Problems of Labor and Management in Economic Growth. Some further research may continue on the prospects for convergence of advanced industrial systems, suggested earlier by the authors as a long-run possibility.

Professor Piore used a leave of absence during the spring term to do research in western Europe on the nature of labor markets in those countries, with particular reference to the role of immigrant labor, racial and ethnic minorities, the relationship of the educational system to the job structure, and the determination of wage and salary structures. This is part of a research project with colleagues in the M.I.T. Departments of Political Science and Urban Studies and Planning, supported by a grant from the Ford Foundation. Professor Piore has continued his interest in research on the process of wage determination. He also presented a paper on "The New Immigration and the Presumptions of Social Policy" at the annual meeting in December of the Industrial Relations Research Association.

Mr. Jacks has continued his work on the impact of Supreme Court decisions on labor relations practice, with particular attention to the use of judicial equity powers to enjoin implementation of management decisions pending arbitration. Professor Emeritus Douglass V. Brown has a continuing interest in legalism in industrial relations in the U.S. on which he has published papers over the past several years.

Professor Emeritus Paul Pigors has been working with Professor Myers on the revision of their book, Personnel Administration, for an eighth edition. Professor Myers used part of his spring term leave for extensive revision of a number of chapters, reflecting new developments in the management of human resources.

Economics and Finance

The work of our Economics and Finance Group is the second general disciplinary pillar supporting our research and teaching programs.

Professor Sidney S. Alexander, head of this group, has continued his work on the normative foundations of public policy. His studies are directed toward the provision of a solid basis for making normative judgments in the social sciences, particularly in economics. An essay on "Social Evaluation Through Notional Choice" was published in November, 1974. He is currently working on the problems of designing equal laws for unequal men. He also has undertaken a study of the international oil market in relation both to United States policy and to the economic and political development of the Middle East. The first part of that study, dealing with the petrodollar problem, will soon be published as a background report for a task force on the Twentieth Century Fund.

Professor Paul W. MacAvoy's major research activity centered on problems of public regulation of industry, particularly with reference to energy. He worked on other aspects of energy problems as well. His study, Economics of the Natural Gas Shortage, (with Professor Robert S. Pindyck) was published in June, 1975. Other publications dealt with the
Professor MacAvoy has been granted leave beginning July 1, 1975, to serve in Washington as a member of the President's Council of Economic Advisers.

Professor Lester Thurow's research focused on the distribution of income. He completed a book, *Generating Inequalities: The Distributional Mechanisms of the Economy*, that will be published in late summer. His publications this year also include "Equity Concepts and the World of Work," "The Economics of Public Finance," and "Tastes, Economic Necessity, the Rational Decision Maker and Social Policies," published in several economic journals. Professor Thurow is currently starting a research project on the income distribution effects of U.S. agricultural exports, which will be supported by the Ford Foundation. Professor Thurow was on leave during the spring term, teaching at the University of Arizona.

Professor Franco Modigliani devoted a major portion of his activities to an effort to influence economic policy away from an emphasis on creating and maintaining a large number of unemployed as the only way of reducing inflation. This activity has involved research that relies in part on an elaborate economic model of the United States, and the presentation of the results to members of the Congress, the Federal Reserve, the profession (by publications in professional journals), and the public at large. Another portion of his research has been devoted to another area of public policy -- namely that of housing. He has participated in and directed a project to study redesign of the present structure of housing financing, including both the mortgage instrument and portfolio policies of financial intermediaries. Other areas of research have included basic issues in stabilization policies, real versus monetary causes of inflation, indexation, capital markets (both domestic and international), and saving behavior. Professor Modigliani is President-elect of the American Economic Association for the coming year.

Professor Daniel M. Holland has continued his studies of property taxation, particularly the effect of the Sudbury decision (in which a Massachusetts court affirmed the need to value all properties at market value for tax purposes), on the distribution of the property tax burden, and property values in Boston. The findings of this research, undertaken jointly with Professor Oliver Oldman of the Harvard Law School, were published by the Boston Urban Observatory early in the fall, and were reported and discussed at a conference of the Committee on Taxation, Resources, and Economic Development in October, and at a special meeting on this subject held by the League of Women Voters in Faneuil Hall the following month. Professor Holland also prepared a manuscript on the tax and regulatory consequences of alternative mortgage designs for the Sloan School's Mortgage Study (directed by Professors Modigliani and Donald R. Lessard). Together with Professor Henry D. Jacoby, Professor Holland prepared a paper on public finance and the energy crisis for the annual conference of the Institute of Public Finance. Over the year, he worked on the early stages of a program in the International Business Project on the rate of return to capital. This project seeks to develop measures on the rate of return to capital comparable, over time, within countries, and comparable, as well, between countries. Scholars in a number of countries, presently nine but quite possibly more in the future, have expressed interest in participating in this project. This interest and its implementation were explored at a meeting held in March when plans to go forward with the project were adopted.

During the past year, Professor Edwin Kuh was on half-time leave, continuing as Executive Director of the National Bureau of Economic Research Computer Research Center for Economics and Management Science, which conducts algorithmic and software development research on data analysis methods, econometric estimation, and mathematical programming. He gave the keynote address at the Computer Science and Statistics Eighth Annual Symposium on the Interface at the University of California at Los Angeles last February. His article on

Professor Robert S. Pindyck worked with Professors Jacoby, MacAvoy, and Gordon M. Kaufman on an interdepartmental project on Energy Resources and Needs. Professor Pindyck's specific interests focus on studies of the economics of the energy system. He has examined dynamic demand-supply models for policy analysis, particularly in the natural gas industry, and, with Professor MacAvoy, has completed construction of a large econometric policy model of that industry. In addition, he has published a book this year, The Economics of the Natural Gas Shortage; North-Holland Publishing Company; Amsterdam, describing the model and its application to policy analysis. The model has been used to examine the effects of alternative regulatory policies on natural gas demand and supply. Professor Pindyck is now beginning work together with Professor Jacoby and Professor Morris A. Adelman of the Department of Economics, on a large simulation model of the world oil market, a project funded by the National Science Foundation (NSF). In addition, he continues his research in the application of control theory to optimal monetary control, to monetary and fiscal policy in a decentralized framework, and to large-scale econometric models. Professors Pindyck and Kuh have recently received an NSF grant to pursue these and related studies of optimal control applications to economic and management policy.

Professor Jacoby has worked on research on several aspects of energy economics, in addition to serving as faculty coordinator for the Economics and Management Program of the M.I.T. Energy Laboratory. His major activity has been in the area of international energy, with one project devoted to analysis of the world oil market, (undertaken jointly with Professor Pindyck and Professors Zenon S. Zannetos of the Sloan School and Adelman of the Department of Economics), and a smaller effort to study the international nuclear industry. He also is involved in various energy policy studies being carried out by the M.I.T. Energy Policy Study Group, with a special focus this past year on a review and evaluation of the analytical work of the Federal Energy Administration in its Project Independence Report, and on the evaluation of Federal programs of research and development in the automotive field.

Professor Robert C. Merton continued his studies of the pricing of options and of corporate liabilities, and more generally, of the operation of financial markets. He also worked on the theory of growth under uncertainty. Papers were completed on each of these topics in April, 1975. He is co-editor of the Journal of Financial Economics and associate editor of the Journal of Finance and the International Economic Review.

Professor Stewart C. Myers continued his research in corporate finance, with particular reference to regulated firms, and published several papers on that subject during the academic year. He was on leave during the spring term, teaching at the London Graduate School of Business.

Professor Donald R. Lessard has been engaged in research in four related areas: alternative nonstandard mortgages, international investment, international financial management, and the role of finance in economic development. With Professor Modigliani, he coordinated the research in the Sloan School Mortgage Study, and contributed papers on foreign experience with alternative mortgages. In the international investment field, he published a paper on a multivariate approach to the structure of gains from international portfolio diversification, and he is currently working on the implications of foreign exchange risk for international investment strategies. In international financial management, he prepared a paper with Professor Lorange on the linkages between planning and control and foreign exchange management in the multinational firm. With Dr. Tamir Agmon, he is working on the prospective investment behavior of petroleum exporting countries.
Professor Cohn also participated in the Sloan School Mortgage Study. As part of this effort, he and Professor Stanley Fischer of the Department of Economics completed a paper analyzing various potential innovations in mortgage design from the standpoint of both borrowers and lenders. Together with Professor Lessard, Professor Cohn presented testimony before the Senate Banking Committee, based on his research on mortgage instruments. Professor Cohn is currently investigating the implications of price-level-adjusted mortgages for the asset management of corporate pension funds. In collaboration with Professors Wilbur Lewellen and Gary Schlarbaum of Purdue University and Professor Ronald Lease of the University of Utah, Professor Cohn investigated the determinants of risk-bearing behavior on the part of individual investors. This research involved a large sample of individual asset portfolios. The results of this study appear in the May, 1975, Journal of Finance. Professor Cohn is continuing his research on financial intermediation. He and Dr. Agmon are examining the role of financial intermediation in economic development.

Visiting Associate Professor E. Eugene Carter has completed a study on a volatility measure applied to a security filter selection process, which is scheduled for publication. Analysis of international corporate finance as a field, with Professor R. M. Rodriguez of Harvard University, has resulted in several working papers and a new 600 page textbook. A working paper based on laboratory experiments with corporate executives concerned their portfolio capital budgeting decisions and the implications for organizational design. An expanded version of this paper, with substantial other materials, has been published as a book. As part of this continuing project, a new survey paper on resource allocations in organizations has been completed.

Dr. Agmon has been engaged in research in the areas of international finance and international business. He has completed a paper on new financial vehicles for developing countries which was published in Intereconomics, March, 1975, as well as a paper on the concept and definition of exchange risk. Together with Professor Lessard, Dr. Agmon is working on a project on the international financial aspects of the energy crisis. This project is related to a larger research effort, on the World Oil Market, of Professors Jacoby, Pindyck, and others in the Sloan School. Also in collaboration with Professor Lessard, Dr. Agmon is completing an empirical study on the behavior of share prices of multinational corporations on the New York Stock Exchange. He and Professor Cohn also are completing a paper on economic development and the growth of financial intermediaries. Dr. Agmon and Professor Charles P. Kindleberger of the Department of Economics are organizing a conference to be held at M.I.T. in January, 1976, on international business activities initiated by small countries.

**Management Science**

The Management Science Group is the third of the Sloan School's principal foci of teaching and research. The group is broadly concerned with models, measurements, and information systems and their impact on managerial processes in a variety of settings. The research of the group can be roughly divided into context-related research, that deals with specific areas of management concern, and methodological research on general tools and techniques. Using this dichotomy, the application areas can be further subdivided into public and private sectors.

A chief concern in the public area has been energy and energy policy. The work has been heavily interconnected with other parts of both the Sloan School and M.I.T., particularly with the Energy Laboratory where Professor Jacoby is a member of the Steering Committee. Professor Jacoby also is the architect of an Energy Policy Study Group and co-principal investigator, with Professor MacAvoy, of the Project Independence Review presented before the Congressional Joint Economic Committee in March, 1975. Professor Jacoby, Professor
Donovan, and a group of students have designed and implemented a New England Energy Information System. Professor Kaufman has undertaken an extensive effort to model the process of oil and gas exploration in order to permit better estimates of undiscovered oil and gas reserves. He has already assisted the U.S. Geological Survey, which recently revised its reserve estimate downward. Professor Jeremy F. Shapiro has started investigation into the development of mathematical programming models of energy systems to better evaluate U.S. policy alternatives with medium term planning horizons.

Health systems are being studied by two members of the group. Professor Urban is conducting research in health maintenance organizations (HMOs). Recent Federal legislation requires employers to offer their employees options of this type if they exist in the employment area, but as is so often the case, very little is known about what attributes of the proposed services are really desired by the intended customers, or what demands or costs will result if various alternatives are offered. Professor Urban is designing and testing a behavioral model of the customer choice process. He also continues his pioneering work in models for the management of family planning systems. The current focus is on a national population planning model for the Philippines. In a somewhat different health direction, Professor Silk has been working to understand and enhance blood donor motivation and recruitment.

The identification and creation of technological aides for policy analysis in state governments has been the thrust of recent work by Professor Little, and students working with him. They have worked with the Massachusetts Deputy Commissioner for Fiscal Affairs to bring into operation an on-line budget tracking system. It permits the Fiscal Affairs staff to make detailed and timely analyses of the Massachusetts state budget.

As food prices continue to soar, the work of Senior Lecturer Gordon F. Bloom on productivity in the food industry takes on increasing importance. Dr. Bloom has been a leader in facilitating the application of new techniques to the food industry through workshops, colloquia, and writings. In particular, a program on Technology Applied to the Food Industry (T.A.F.I.), which was started at M.I.T., now is being extended to other universities.

Professor Arnold I. Barnett's statistical work on victimization from crime has attracted wide attention among people concerned with urban problems because it reveals a remarkably high probability that people living in certain areas will have crimes committed against them.

A variety of work has been going on in the private sector, especially in the areas of marketing and operations management. In marketing, Professors Silk and Urban have devised measurement techniques and supporting models to predict long-run market shares for new products prior to the expensive and often unreliable step of test marketing. In addition, Professor Urban has developed related techniques for new product design and positioning, and Professor Silk has been studying affective qualities of advertising and their relationship to customer response. Professor Lilien has embarked on a major study of industrial advertising in which 12 cooperating companies have provided cross-sectional marketing data on 70 industrial products. The study seeks to determine how industrial advertising budgets are related to product and market characteristics.

Although management science techniques have long been helpful to companies in designing and installing production planning systems, a number of difficulties plague applications. Particularly serious has been the compartmentalization of problems into small systems that really should be connected to large ones. At the same time, large complicated systems have often collapsed as the designers have moved on to other responsibilities. Professor Hax is engaged in a project on hierarchical production and distribution systems which seeks to tackle these issues. In his work, models for higher level strategic decisions set constraints for more local tactical decisions from which the latter feed back information to the former.
In this effort Professor Hax is working closely with Professor William A. Martin who seeks to add automatic programming ideas to the design of such systems so that they will be more readily adaptable to new managers and new operating conditions.

The ability to extend knowledge and solve problems in context areas such as those cited above depends on continued basic methodological research. Considerable activity along these lines is taking place within the Management Science Group. Professor Michael S. Scott Morton is chairman of an American Accounting Association standing committee on Management Planning and Control and has taken on responsibility for preparing a position on concepts and research issues in management control. Professor Lorange is studying formal planning systems, especially in the complex setting of multinational corporations. Professor Sitikantha Manapatra is examining the efficiency and effectiveness of computer-based planning and control models across organizations.

A major methodological thrust within the group is mathematical optimization. Many large scale systems are potentially capable of improvement by these techniques. A surge of theoretical developments in recent years has not yet been well integrated into practice because of lack of adequate computational support and because of a few important stumbling blocks in the theory. Recent research by Management Science Group faculty has been directed toward these issues. Professor Shapiro has been supervising the development of a modular system of mathematical programming packages at the National Bureau of Economic Research installation in Cambridge. He also has focused research effort on certain outstanding issues in integer and mixed integer programming. Professor Thomas L. Magnanti has been attacking problems in combinatorial theory and nonlinear programming and has had a particular concern for optimization in large linear programming models. Professor Marsten has brought together two previously separate mathematical programming methods, branch-and-bound and dynamic programming, and discovered that substantive new computational efficiencies can thereby be gained. Professor Michael E. Werner, a visitor from the Technical University of Berlin during the past year, has been contributing in the area of resource allocation on networks.

Computer-based information systems consume large quantities of resources in the national economy and generate more than their share of concern and controversy. Stimulated in part by the stringent requirements of energy information systems for policy analysis, Professors Donovan and Madnick have been laying foundations for a computer system architecture that allows multiuser access to a single data base, use of multiple and potentially incompatible modeling languages to access the same data base, and access to multiple and potentially incompatible data base management systems. In related work, Professor Peter P. Chen has worked on a theory of data base design and on analytic models for use by a data processing manager to select the most cost-effective computer system configuration.

Professor Scott Morton has been studying the impact of advanced decision support systems on the organizations using them. Students working under his direction have been doing research on issues of systems implementation in specific settings. Professor Jeffrey A. Meldman has been investigating issues in computer-aided legal analyses. Dr. Rockart has embarked on a study of distributed computing power in large organizations.

An emerging concern among statisticians is the distortion of estimation and inference by "bad" data. This has given rise to the field of robust statistics. Professor Roy E. Welsch has been developing robust nonlinear regression techniques and implementing them on easy-to-use computer systems. Recently he has worked with Professors Little and Silk to use methods for calibrating nonlinear marketing models.
**System Dynamics**

System dynamics research is now concentrated on the national socioeconomic model that has been under development for three years. This research program is sponsored by the Rockefeller Brothers Fund and is directed by Professor Forrester in collaboration with Professor Nathaniel Mass, Research Assistant, Gilbert Low, and other members of the group. Most of the sectors of the model have been completed in preliminary form. Sectors describing production processes, labor mobility, banking, savings institutions, and the monetary authority have been individually tested. Assembly of the model has begun. Initial computer simulation studies are leading to improvement of the model and to preliminary examination of business cycles and longer-term fluctuations in the economy. Only parts of the entire model are needed for examining many important national issues; the sequence of assembly is scheduled to allow study of a progression of critical questions even before the final sectors are completed. With preliminary sector descriptions becoming available, outside groups are being consulted for advice on improvement of the model, and interaction with potential users is growing as the model materializes.

In stages during the next three years, the model should assist in:

- further understanding of business cycles;
- the possible role of a 50-year wave in the economy in causing the present recession to be deeper than expected;
- the meaning of simultaneous inflation and unemployment;
- the energy shortage;
- the relationships between rising population and the standard of living; and
- the pressures from growth impinging on environmental limits.

**The Management of Science and Technology**

Research here concerns itself primarily with the dynamics of generating technical innovation and the processes which determine the circulation of technical information between organizations. Professor Farris continues his work in this area, at the level of the technical group. The makeup and supervision of technical groups continue to be a topic for intensive research.

Professor Allen continues his work on technology transfer. His principal concerns have been the acquisition of new technology by organizations and the effective dissemination of this information within organizations. More recently, his attention has been turned to the same problems at the national level. The first country to be investigated was the Republic of Ireland, and preparations are now underway for similar studies in Norway and Brazil. Some of the more interesting results from the national studies involve marked differences in the ways in which different disciplines structure themselves for international communication. Professor Allen has just completed a book which will cover almost a decade of his research in this area. Professor Roberts continued to work on system dynamics problems relating primarily to technology and health issues; he also did some empirical studies on new ventures.

Professor von Hippel's research this year focused on better understanding of how the manufacturer of an innovative industrial good gains an accurate understanding of the user need for that good. Previous research has shown that such "accurate understanding of user need" is a key to successful industrial good innovation. Research into scientific instrument innovations shows that users of such goods play a very active role in defining needs and informing instrument manufacturers of their requirements.
The joint M.I.T.-Harvard Program on the Management of Technology, under the auspices of the Sarnoff endowments, continues to develop. This year, Professor Roberts continued the joint seminar which focused on the commercial exploitation of technology in industry, government, and university settings.

Professor Allen also engaged in some joint research with the Center for Policy Alternatives and the Department of Political Science. This research involved an evaluation of government policy to stimulate innovation in four Western European countries and Japan. The results of the research should be valuable in formulating U.S. policy in this important area.

As the group achieves a greater understanding of how technological innovations come about and are diffused, it will be possible to stimulate the process of such diffusion on a much wider scale, both at the level of a small system, such as a laboratory, and a large system, such as research and development in a country.

Corporate Strategy -- Business Policy and Strategic Planning

The demand for subjects in the general area of corporate strategy continues to be strong in all of our programs. Because of this varied program demand, the members of the group have continued to devote a considerable amount of effort to curriculum development. The basic subject has been restructured and two experimental subjects are being planned for the coming year. The new experimental subjects will deal with corporate financial strategy and research topics in the general area of corporate strategy, policy, and planning.

New members of the group are Professor Edward M. Graham on a full-time basis, and Professor Carter on a part-time visiting basis. They have both been of great assistance in teaching the scheduled subjects. In addition, Professor Graham assisted in the planning and execution of a joint seminar with the International Management Group. In terms of research the members of the group continue to pursue their own individual interests. Professor Carter is involved with issues of financial strategy, Professor Graham with direct investment of foreign multinationals in the United States, and Professor Zannetos with organization structures, strategic planning, and oil economics, with particular emphasis on the economics of ocean transportation of oil by tankers. In addition, the group is formulating plans for group projects centered around industry studies.

International Management

A project to examine worker participation in management in Peru, undertaken in collaboration with the Center for International Studies, is near completion. During the summer of 1974, long interviews were conducted with workers and managers, and the final report is now being prepared. Professor Richard D. Robinson is directing the study.

Two other projects are concerned with Brazil. First, faculty members and students are working with the Center for Policy Alternatives on a project sponsored by the Projecto Ciencia e Tecnologia in Sao Paulo, which will examine alternative policies and programs for the support and promotion of economic growth and development. Shing Fung, a doctoral candidate, is currently in Brazil engaged in field research. Second, Professor Mericle is completing an intensive study of the Brazilian automobile industry based, in a large part, on field research conducted during the summer, 1974.
Research

Professor Robinson completed a survey of foreign investment entry control systems in a number of Latin American and Asian countries, based on field research conducted during the past summer.

Professor Stephen J. Kobrin is completing a study of the impact of social, political, and economic environmental variables on flows of U.S. foreign direct investment. He also is beginning an investigation of the effect of foreign investment on social modernization -- on individual values and attitudes, and on managerial recruitment and promotion policy -- in developing countries. Professors Lessard and Kobrin have recently completed an analysis of the probability of large-scale flows of foreign direct investment from OPEC investors to the U.S. Professor Lessard also has continued his work on international investment, concentrating on: 1) the gains from international diversification of investments, 2) the determination of international portfolio strategies for U.S. institutional investors, and 3) an application of the portfolio framework to direct foreign investment.

Dr. Agmon and Professor Lessard are initiating an investigation of the prospective investment behavior of petroleum exporting countries and its interaction with their output decisions. They also are conducting an analysis of the effect of international diversification of the multinational corporation on the price behavior of stock shares. In addition, Dr. Agmon is conducting an investigation of the desirability of international business activity for small country corporations from both a micro and macro viewpoint. The project will culminate with a conference at M.I.T. in late 1975.

Professor Nyhart is working on the emerging legal-regulatory framework for the management of ocean technology and resources. He has completed an analysis of the legal structure of the ocean mining industry and is in the process of completing a study of the regulatory aspects of offshore structures and uses.

Health Care Management

The past year witnessed the launching of new educational programs in health care management, a significant increase in related research, and a major effort to develop a critical mass in this relatively new area.

The Sloan School continued its active collaboration with the Association of American Medical Colleges (AAMC) in an ongoing three-phase program involving the development and presentation of management education programs for the AAMC's constituent medical schools. Mr. Beckhard and Professor Roberts, representing the behavioral sciences and the management sciences, respectively, have exercised joint responsibility for design, initial implementation, and ongoing faculty leadership of these activities, with additional support provided by Professor Urban and Dr. Rockart of our School and numerous faculty recruited from other universities. Phase I of the program is for deans, and to date has involved 90 deans of the 114 North American medical schools. More than 50 medical schools have already participated in the follow-up Phase II teams program. And Phase III, just underway, has been attended by 13 institutions seeking to accelerate programs of managerial improvement. Additional sessions of all three phases are scheduled for the coming year. In a related activity, Dr. Rockart has developed and implemented a short course for the business and planning officers of the medical schools, and the AAMC has conducted two of these programs.

Professor Roberts continued to expand the size of his five-day course on application of system dynamics to health service systems. Publication of new works in that area, including his book on the growth of urban heroin addiction, has accelerated outside interest in the field.
Mr. Beckhard, aided by Lecturer Irwin Rubin and Research Associates Eric Herzog, Mark Plovnick, and Nina Rosoff, has developed a broad series of educational programs, funded by the Robert Wood Johnson Foundation and aimed at bringing about change in various health institutions. The new curricula have already resulted in one book on developing health teams, with another book in progress on educational interventions in health fields. The principal effort of Mr. Beckhard and his associates is to develop team building materials for health care teams, to test these materials in a field setting, to determine the extent to which such materials can be used without the active intervention of outside consultants, and to determine what kinds of new curricular materials or educational strategies can be inserted into medical school and post-graduate programs for health care personnel to improve their overall effectiveness.

In addition to the research interests of Professor Roberts and Mr. Beckhard, mentioned above, significant progress was made by Professor Urban in developing a model of consumer response to health services and testing it in the pilot operation of the M.I.T. Health Plan, a new health maintenance organization. Structured interviews with 447 enrollees and prospective members of the plan generated a forecast of consumer acceptance and led to a refined design of the planned health services.

Professor Harris advanced his research on the client orientation of health care organizations, carrying out field work in a sample of 12 ambulatory care organizations. Preliminary analysis of data from 218 staff members and 527 patients suggests that the informational perspective the organization takes towards its patients is related to the patients' evaluation of the quality of care received.

Dr. Rockart has extended his earlier interests in the area of "disease costing" to include both in-patient and out-patient settings, and is now focusing on the possible role of distributed information processing systems to aid patient management in hospitals. Professor Silk expanded his collaborative activities with the M.I.T. Operations Research Center in an effort to understand blood donor motivation and recruitment. This research, funded by the U.S. Bureau of Health Services Research, will lead to a pilot implementation stage in which experiments are carried out for improving blood collections.

At the policy analysis level, Professor Roberts has been working with a Greater Boston area group led by Professor Harvey Sapolsky of the Department of Political Science to create a faculty-level health policy seminar. A series of meetings with key officials of the U.S. Department of Health, Education and Welfare has led to a tentative focus for the seminar, which will continue on a broadened basis in the fall.

Major efforts by numerous Sloan School faculty and the Dean's Office have been directed at moving the health management area toward the establishment of a critical mass of program and faculty. Extensive discussions with the Harvard Medical School have produced an expanded basis for collaboration with its Center for Community Health and Medical Care. Plans have been developed for the launching of a major research center on health care management, and substantial funds are being sought that would permit formal implementation of these plans. The launching of our new Health Management Executive Development Program has already been noted, and additional efforts are also under way to add new educational programs to the Sloan School's health management activities.
International Visitors

Dr. Yvan Allaire, on leave from the Université du Québec in Montreal, visited the Sloan School as a Visiting Associate Professor of Management during the spring term, 1975. During this period Professor Allaire taught Marketing Management and Marketing Communications.

Visiting Assistant Professor Ezio Tarantelli, on leave from the Bank of Italy where he is a member of the Economic Research Department, joined the Industrial Relations Section for the fall term, 1974, during which time he assisted Professors Myers and Piore in teaching Manpower and Labor Relations subjects.

Michael E. Werner of the Technical University of Berlin joined us during the academic year as Visiting Assistant Professor, with Professor Shapiro acting as his host. Dr. Werner teaches Operations Research in the Department of Cybernetics at the Technical University.

Gabriel Bitran, on leave from the Escola Politecnica of the University of Sao Paulo in Brazil, joined us as a Research Associate for spring term, 1975. He assisted Professor Hax on a research project at the Operations Research Center.

Dr. Tamir Agmon, Assistant Professor of Finance and International Finance at the Leon Recanati Graduate School of Business Administration at Tel Aviv University in Israel, has been a member of the finance area of the Sloan School during the past year, teaching subjects dealing with corporate finance, portfolio theory, and financial problems of international enterprises.

Dr. Meyer Feldberg, with Dean Gil as his faculty sponsor, was a Visiting Scholar with the Sloan School and the Center for International Studies during the fall term. Dr. Feldberg came to us from the University of Cape Town in South Africa where he is a Professor and Director of the Business Programs.

During the past year, William R. McLennan of the University of Sheffield in England joined the Organization Studies Group as a Visiting Scholar, as did Professor Roger E. Miller of the Université du Québec à Chicoutimi.

Under the sponsorship of the International Research and Exchange Board, Tamaz Sergevish Baramidze, Assistant Professor at Tbilisi State University in the U.S.S.R. visited our Management Science Group as a Research Fellow. Under the same sponsorship, Andrej Evans, Assistant Professor at the Latvian State University, visited the Sloan School's Center for Information Systems Research.
Staff Changes and Promotions

During the past year we have been singularly honored to have three Sloan School professors named to special chairs: Professor Paul W. MacAvoy was named Henry R. Luce Professor of Environment and Public Policy; Professor Edward B. Roberts succeeds Donald Marquis as the David Sarnoff Professor of Management; and Professor Carroll L. Wilson became the Mitsui Professor in Problems of Contemporary Technology. Professors MacAvoy and Wilson are the first to hold the title for their respective posts.

Professors Thomas J. Allen, Robert C. Merton, and Alvin J. Silk were promoted to the rank of full Professor. Associate Professors Stewart C. Myers, D. Quinn Mills, and Glen L. Urban were granted tenure.

Professor Mason Haire was on a personal leave of absence last year. Professor Charles A. Myers was on sabbatical leave for the spring term, 1975, during which period he did research and writing for a book in the field of management of human resources. During Professor Myer's absence, Professor Mills was named acting director of the Industrial Relations Section. Professor Lester Thurow spent the spring term teaching at the University of Arizona; Professor Roy E. Welsch was on half-time professional leave to act as a Research Associate at the National Bureau of Economic Research Computer Research Center for Economics and Management Science; Professor Stewart C. Myers was a visitor at the London Graduate School of Business, devoting most of his time to research; and Professor Michael S. Scott Morton spent his sabbatical leave in Scotland.

We were fortunate to have with us as Visiting Professor with the Management Science Group, Dr. Murray A. Geisler, Director of the Logistics Program of the RAND Corporation. Also joining that group as Visiting Professor was James S. Hekimian, Dean of Business Administration at Northeastern University. Dr. E. Eugene Carter, formerly of the Harvard Business School, became Visiting Associate Professor during this past year with the Economics and Finance area.

J. Morgan Jones, on leave from the University of California at Los Angeles, joined the Management Science Group as Visiting Associate Professor; and Dr. Norman S. Stearns joined us for the spring term as Visiting Associate Professor to assist master's degree and doctoral students who worked in the health management area. Also with us for the spring term was Dr. David S. McClain, on leave from Data Resources, Inc. As a Visiting Assistant Professor, Dr. McClain taught a seminar in International Economics. Dr. Francis N. LeBaron, Chairman of the Department of Biochemistry, University of New Mexico School of Medicine, was a Visiting Scholar for the past year, with Professor Edgar H. Schein acting as his host.

Newly appointed Assistant Professors include Dr. Arnold I. Barnett, formerly with the M.I.T. Department of Mathematics; Dr. Peter P. Chen, who left Honeywell Information Systems where he was Principal Engineer; Dr. Sitikantha Mahapatra who came to us from Bowling Green State University; and Dr. Jeffrey A. Meldman who transferred from the M.I.T. Department of Electrical Engineering and Computer Science. These four men were welcome additions to the Management Science area.

Dr. Edward M. Graham joined the Sloan School Corporate Strategy Group, coming to us from the Harvard Business School; Dr. Reuben T. Harris, a new member of the Organization
Staff Changes and Promotions

Studies Group, came to us from the University of California at Berkeley. The International area was expanded to include Stephen J. Kobrin as Assistant Professor. Professor Kobrin was formerly a Research Fellow with the Michigan Department of Commerce.

Donald R. Lessard was reappointed as Assistant Professor with the Economics and Finance Group, and Dr. James M. Lyneis came to us from the University of Michigan to join the System Dynamics Group.

Robert B. O'Connor, Jr., former geophysicist and director of exploration research for the Shell Oil Company, was appointed a Senior Research Associate in the System Dynamics Group. Also appointed Senior Research Associate was Norman L. Rasmussen, formerly Senior Systems Consultant at IBM. In addition, Mr. Rasmussen served as acting director of the Center for Information Systems Research during Professor Scott Morton's leave of absence. Dr. Harlan C. Meal of Arthur D. Little, Inc. was a part-time Senior Lecturer this spring, assuming teaching duties in the Management Science area.

Working with Professor Carroll L. Wilson on a seminar on Strategies for Sustainable Growth was David D. Gray, who served in this capacity for the past year. Drs. Plovnick and Rosoff joined the Health Management Project being conducted by Mr. Beckhard and Dr. Rubin. After receiving his Ph.D. in the Department of Economics at M.I.T., Martin Zimmerman joined Professors Morris A. Adelman and Henry D. Jacoby in an Energy Laboratory project as a Research Associate. Joel Skolnick, a Staff Accountant for Price Waterhouse & Company, was a part-time lecturer in the Management Science area, assisting Dr. John F. Rockart.

We also are happy to record the change of name and title for Leslie Clift Hruby who became Sloan School Director of Placement, and Assistant to the Dean. A new position of Manager of Financial Information and Planning was created this year. Frederick J. Quivey, who came to the Sloan School from the joint Harvard-M.I.T. Program in Health Sciences and Technology, has been named to this post.

We record with regret several departures from the Sloan School. Professor Edward H. Bowman left to become Dean of the Ohio State University College of Administrative Science, and Professor Myron S. Scholes joined the faculty of the University of Chicago Graduate School of Business. Professor Peter G.W. Keen will assume a post at Stanford University this fall, and Professor George F. Farris will be working at the European Institute for Advanced Studies of Management, in Belgium. Professor James E. Annable, Jr. accepted a post with the Board of Governors at the Federal Reserve System, and Professor John Henize will join the Industrie Seminar Der Universitat Mannheim in West Germany.

WILLIAM F. POUNDS
Activities in the School this year emphasize the way faculty and students are involved in extending our understanding of basic science and, at the same time, are involved in its application. The world's problems have produced increased needs for knowledge of the physical sciences which provide the basis for energy and materials and of the biological sciences which provide the basis for health care and food supply. In all of these areas, we know that the world of the future will be quite different from the world of the present. There is also increased pressure for knowledge of the earth, and M.I.T.'s response is illustrated by the programs in oceanography, seismology, meteorology, geophysics, and water chemistry. Underlying all these scientific fields is our knowledge of mathematics, pure and applied, and our recently acquired capacity to undertake larger problems through the use of electronic computers.

The School of Science is heavily involved in a number of the interdepartmental laboratories which make possible larger projects, and a further involvement with practical applications. In the physical sciences, faculty in the School are involved in the Center for Space Research, Haystack Observatory, Laboratory for Nuclear Science, Center for Materials Science and Engineering, Francis Bitter National Magnet Laboratory, and Research Laboratory of Electronics. In the biological sciences, faculty in the School are involved in the Arteriosclerosis Center, Center for Cancer Research, Cell Culture Center, Clinical Research Center, and the Harvard-M.I.T. Program in Health Sciences and Technology. The Wallace Astrophysical Observatory, the George R. Wallace, Jr. Geophysical Observatory, and the Spectroscopy Laboratory operate within the School of Science.

We are proud of the Department's connections with applications, but we also strive to support basic research not apparently connected with applications. While no one can predict accurately just where new major discoveries will be made, we do know that they arise from activities of high quality.

The number of undergraduate students with designated majors in the Institute as a whole was down 3.8 percent this year, compared with 1973-74, or 3,095 compared with 3,218. The undergraduate enrollment in the School of Science was down 5.4 percent from 1973-74, 1,110 compared with 1,173. However, the graduate enrollment for the Institute as a whole was up 3.3 percent from 1973-74, 3,468 compared with 3,358, and the graduate enrollment in the School of Science was up 3.9 percent from 1973-74, 970 compared with 934.

The major new educational program development of the year is the Master of Science Program in Interdisciplinary Science managed by the Course 25 Committee. The Course 25 Committee, which consists of one member of each of the departments in the School of Science, plus a representative of the Department of Psychology, has enjoyed so much developing interdisciplinary programs with undergraduates that it was attracted by the idea of applying this approach at the master's level. They feel that industry and government increasingly need scientists trained at a higher level than the bachelor's degree, but without the orientation toward careers in research that characterizes the doctorate. On December 18, 1974, the M.I.T. faculty approved this program for an experimental three-year period, and the Course 25 Committee has already admitted the first graduate students for fall, 1975, on the basis of programs suggested by students and negotiated with an advisor and the Committee.
In addition to these individual programs, the Course 25 Committee was authorized to develop specific interdisciplinary programs for groups of students. So far, two programs have been developed by faculty committees and checked by the Committee on Graduate School Policy. The science education program will be supervised by a subcommittee of the Course 25 Committee, headed by Professor Earle L. Lomon of the Department of Physics. The Animal Cell Science Program will be supervised by a subcommittee of the Course 25 Committee, headed by Professor Phillips W. Robbins of the Department of Biology. The purpose of the Science Education Program is to provide advanced preparation for educators in the areas of school science instruction and in the administration of systems in which science instruction is a significant component. The Animal Cell Science Program involves experimental work in the new Cell Culture Center as well as subjects offered by the Departments of Biology and Nutrition and Food Science.

Professor Louis N. Howard of the Department of Mathematics has resigned as faculty counselor for the Course 25 Program and has been succeeded by Professor John M. Buchanan of the Department of Biology. Professor Howard has carried these responsibilities for two years with distinction and has been very much involved with the development of the new S.M. Program. The undergraduate program in Course 25 had 17 majors in September, 1974, and nine students will receive the S.B. degree in Course 25 this year.

Two new options will be offered to freshmen in September, 1975, for the satisfaction of the Institute's Science Requirement. Chemistry 5.40 will be given to provide a broader introduction to the basic ideas and substance of chemistry. Mathematics 18.01X will be offered to freshmen who prefer to satisfy the calculus requirement with a subject with more lectures and tutorial help.

In the fall term, the School of Science offered 24 undergraduate seminars which enrolled 258 students (197 freshmen and 61 upperclassmen). In the spring term there were 14 seminars and a total of 113 students (55 freshmen and 58 upperclassmen). The Undergraduate Research Opportunities Program (UROP) continues to be very popular in the School.

This year in the School of Science, the highest enrollment in subjects other than the Science Requirement subjects were 427 in 5.42 Organic Chemistry; 371 in 7.05 General Biochemistry; 346 in 8.03 Physics III; 832 in 18.03 Differential Equations; and 402 in 18.075 Advanced Calculus for Engineers. Since the maximum steady enrollment of any undergraduate subject is about 1,000, it is evident that very high percentages of all undergraduate students are taking these science subjects.

The reports of the Career Planning and Placement Office for 1972-73 and 1973-74 do not indicate much change in the types of jobs taken by graduates in the School of Science immediately upon graduation. A large number of S.B. candidates go on to further study; 60 percent in 1972-73 and 65 percent in 1973-74. A significant number of Ph.D. candidates take postdoctoral work at M.I.T. or elsewhere. 34 percent in 1972-73 and 36 percent in 1973-74. In general, 1973-74 was a better year for jobs than any of the three preceding years. A study of doctoral scientists and engineers in the nation as a whole, carried out in fall, 1973, found that 1.1 percent were unemployed at that time.

Research

The research volume for the School is expected to be up about 12 percent for fiscal year 1975 over fiscal year 1974, when the final figures are in, and the expenditure level in the School of Science expected by the Office of Sponsored Programs is $20,619 for fiscal year 1975.
1975 compared to $18,279 for fiscal year 1974. These figures do not include expenditures in the interdepartmental laboratories where School of Science faculty are involved.

The University of Michigan, Dartmouth College, and M.I.T. formed a consortium to move the 1.3-meter optical telescope of the University of Michigan to Kitt Peak where it can be used in joint and separate programs of the three institutions. This development was stimulated by the needs of the group in the Space Center to identify optically the X-ray emitting stars discovered by the Small Astronomical Telescope C (SAS-C) satellite. The satellite was launched successfully on May 7, 1975, and the telescope is already in operation. The telescope has been rededicated as the McGraw-Hill Observatory in honor of a generous gift from the McGraw-Hill Book Company. The success of the project was also insured by a gift from the Sloan Foundation.

On May 20, 1975, the new George R. Wallace, Jr. Geophysical Observatory was dedicated. The idea for this remarkable new facility was developed by Professor Frank Press and was made possible by a gift from Mr. and Mrs. George R. Wallace, Jr., of Fitchburg. The Observatory is located close to the George R. Wallace, Jr. Astrophysical Observatory in Westford, Massachusetts. Professor M. Nafi Toksöz will serve as director. Seismometers and tilt meters in an underground vault are tied into the computer in the Astrophysical Observatory and readings are also recorded at the Cecil and Ida Green Building.

On March 6, 1975, the recently completed Seeley G. Mudd Building was dedicated. This building houses the Center for Cancer Research, a new interdepartmental laboratory involving 11 faculty members in the Department of Biology. A closely related and new facility in the same building is the Cell Culture Center directed by Professor Robbins.

On December 4, 1974, the first decade of the Green Building was celebrated by a program in honor of Cecil H. and Ida M. Green. The common meeting place in the building was dedicated as the Ida Green Room. We are all grateful to the Greens for their support of the Institute.

Faculty

Three faculty members from the School retired this year, Professor Sanborn C. Brown of the Department of Physics, Professor Albert G. Hill of the Department of Physics, and Professor Irwin W. Sizer of the Department of Biology. They all have spent their careers at M.I.T. and all retired from important administrative positions -- Professor Brown as Associate Dean of the Graduate School, Professor Hill as Vice President for Research, and Professor Sizer as Dean of the Graduate School. They will be very much missed from their accustomed roles.

One of the special symposia of the year was organized to honor Professor Victor F. Weisskopf who became an Emeritus Institute Professor on July 1, 1974. This year there are two additions to the senior faculty of the School from outside M.I.T. Dr. Robert J. Birgeneau of Bell Laboratories is joining the Department of Physics, and Dr. Stanley R. Hart of the Carnegie Institution is joining the Department of Earth and Planetary Sciences. We have lost Professor Richard H. Holm of the Department of Chemistry to Stanford University and Professor Elliott H. Lieb of the Departments of Mathematics and Physics in Princeton University.
Individual faculty members received many honors during the year and Professor Holm and Professors Edward N. Lorenz of the Department of Meteorology, and Clifford G. Shull of the Department of Physics were elected members of the National Academy of Sciences.

ROBERT A. ALBERTY

Department of Biology

During the year, 412 undergraduate students concentrated in the life sciences and 144 were awarded the Bachelor of Science degree in this field; the previous year's figures were 361 and 146, respectively. Between July 1, 1974, and June 30, 1975, 15 Doctors of Philosophy and six Masters of Science were awarded in Biology. During this year we awarded our first Doctor of Philosophy in Biological Oceanography under the joint program with the Woods Hole Oceanographic Institution. There were 110 graduate students in the department during the past year. Approximately 42 undergraduate students participated in research programs during the regular academic year. Professor Robert A. Weinberg has been acting as coordinator of our undergraduate research program.

The first John L. Asinari Award for research was presented to Andrew D. Pauli. Offered jointly by the Departments of Biology and Nutrition and Food Science, the award will be given annually to a senior in the life sciences for the most outstanding undergraduate research conducted in our departments. John Asinari was a student in biology and met an untimely death shortly before the end of his last term at M.I.T. He was one of our best students and his loss is a substantial one to all concerned.

Research

The research by members of the Department's faculty, research associates, research fellows, and graduate students is described in a publication entitled "Research Summaries." It is available at Departmental headquarters.

Faculty

Associate Professor Uttam Lal RajBhandary was promoted to full Professor as of July 1, 1975. Associate Professors David Botstein and Jonathan A. King have been awarded tenure to become effective July 1, 1976. Professor Botstein is currently spending his sabbatical year at Cold Spring Harbor Laboratory to study yeast genetics. Assistant Professor Boyce W. Burge left our Department to accept a position at the Worcester Foundation for Experimental Biology in Shrewsbury, Massachusetts. Professor Sheldon Penman was elected to the American Academy of Arts and Sciences.

BORIS MAGASANIK
Fifty-three undergraduates were awarded the Bachelor of Science degree in chemistry this year: one in September, 1974, 14 in February, 1975, and 38 in June, 1975. The graduates plan to continue their educations by attending graduate school in chemistry, medicine, law, business administration, or have been employed by industry. The degree of Master of Science was awarded to eight candidates: two in September, one in February, and five in June. A total of 40 Doctor of Philosophy degrees were awarded to 16 candidates in September, nine in February, and 15 in June. To date, 1,424 Ph.D. degrees and 350 Master's degrees have been awarded by the Department.

Personnel

Professor Shneior Lifson of the Weizmann Institute of Science in Rehovot, Israel was a Visiting Professor in the Department this year. Professor K. Barry Sharpless was promoted to the rank of Professor. Paul R. Schimmel and Jeffrey I. Steinfeld were promoted to the rank of Associate Professor with tenure and Sidney M. Hecht was promoted to Associate Professor. The Department of Chemistry has appointed five new Assistant Professors: Drs. Carol D. Meyer and William H. Rastetter to the Organic staff, Drs. Richard R. Schrock and Edward I. Solomon to the Inorganic staff, and Dr. Ralph H. Staley who joined our Physical staff.

Professor George M. Whitesides received the American Chemical Society Award in Pure Chemistry and has been elected a fellow of the American Academy of Arts and Sciences. Professor Jack E. Baldwin is the recipient of the 1973 Corday-Morgan Medal and Prize in Organic Chemistry from The Chemical Society, London. Further recognition immediately followed with his "Blue-Black Blood Substitute," a molecule that binds and releases oxygen much like hemoglobin.

Professor Fritz S. Klein of the Weizmann Institute of Science in Rehovot, Israel was also a Visiting Professor in the Department. Some of our other visiting faculty and scientists were as follows: G. Robert Greenberg of the University of Michigan; John F. Garst of the University of Georgia; Arthur H. Landy and Edward A. Mason of Brown University; Kevork V. Nahabedian of State University of New York at Geneseo; Arnet L. Powell of the Office of Naval Research; Kageyasu Akashi of the University of Tokyo, Japan; Jean C. Brunie of the University of Lyon, France; Ender A. Erdik, Ankara University, Turkey; Shoji Inoue, Osaka University, Japan; John G. Jones, New University of Ulster, Coleraine, Ireland; Dolores Juarez, Universidad Iberoamericana, Mexico; Eric Oldfield, Sheffield University, England; and Alfred Pollak, University of Ljubljana, Yugoslavia.

The Department was privileged to sponsor a series of lectures by the Arthur D. Little Visiting Professorship. Visiting Professor Harry B. Gray of the California Institute of Technology gave two lectures: "Recent Studies on the Structures and Electron Transfer Reactions of Copper Proteins" and "Electronic Structure and Excited State Reactivity of Complexes Containing Metal-Metal Bonds"; and Professor Kenneth L. Rinehart, Jr. of the University of Illinois at Champaign-Urbana gave three lectures: "Chemistry and Biology

Curriculum

The options for entering undergraduate students in chemistry subjects are as follows: 5.41 Introduction to Structure, Bonding, and Mechanism; 5.60 Chemical Equilibrium; 3.091 Introduction to Solid State Chemistry; and 7.01 General Biology. The new subject in biochemistry, 5.50 Enzymatic Reaction Mechanisms, that previously was taught by Professor Christopher T. Walsh on an experimental basis, has become a regular course offering will be taught each spring term.

Research

Research in the Department of Chemistry is carried out by members of the faculty, postdoctoral fellows and associates, and graduate and undergraduate students. Our active research, in a large variety of fields, is described in a publication entitled "Faculty Research Projects Available as Graduate Thesis Topics," which may be obtained in our Graduate Office.

The following is a description of a few representative research programs which are in progress in our laboratories.

Professor Robert W. Field's research program on structure and dynamics of small, electronically excited molecules is dependent upon three technical components: tunable lasers, optical frequency measurement, and molecular production. Design, fabrication, and ordering of parts for four tunable, continuous wave dye lasers is now complete. Two of these will be used in collaboration with Professor James L. Gole and Professor David Pritchard of the Department of Physics. These lasers will have stability and spectral bandwidth superior to commercially available lasers. The first laser was recently assembled and is currently being tested. Optical frequencies will be measured using Fabry-Perot etalons to provide frequency markets. Etalons are being calibrated using the high resolution spectrographs in the M.I.T. Spectroscopy Laboratory. A variety of metal oxide, halide, sulfide, and hydride diatomic molecules can be prepared in a 1-10 torr vacuum flow system. Two ovens, capable of vaporizing metals at temperatures up to 2,000 K, and their associated vacuum systems, have been constructed and tested. Chemiluminescence and laser-induced photoluminescence have now been observed in these systems.

Current research problems fall into three groups: applied theoretical, optical-optical double resonance (OODR), and optically pumped electronic transition lasers. Theoretical research focuses on Born-Oppenheimer breakdown phenomena. A study of perturbations between valence states of NO was recently completed. Several partially analyzed perturbations in SiS, SiO, BeO, and BeS are being reanalyzed with the goal of vibrationally and electronically assigning the perturbing states. Another project involves collaboration between a graduate student, Richard Gottscho, and one of Professor Jeffrey Steinfeld's graduate students Bruce Garetz, on the effect of perturbations on energy transfer between the $A^2Π$ and $X^2Σ$ states of CN. The first OODR experiments will be attempts to locate theoretically predicted but
experimentally unknown long-lived, low-energy excited states of BaF and BaO. The BaF_2^2\Delta and BaO_3^3\Sigma^+ states may have thermochemical importance and also act as energy reservoirs in metal plus oxidant flames. Later OODR experiments will investigate rotation to translation energy transfer processes and radiationless processes (preparation of nonstationary states, predissociation) in polyatomic molecules. In addition to providing a hint of device-oriented reality, an optically pumped laser program is intended to assess the importance of vibration to electronic energy transfer in reactions which are electronically chemiluminescent with high photon yield. The first optically pumped laser will be a cw BaO A^3Σ(v=1)→ X^1Σ(v=7) laser excited by a tunable dye laser.

Professor Ellen J. Henderson's research group is undertaking analysis of the functional organization of membrane proteins and the changes in membrane proteins during the differentiation of the eucaryotic microorganism Dictyostelium discoideum. The group is developing and exploiting both chemical and biochemical probes which can detect polypeptide aggregates within a membrane and distinguish between aggregates which are oriented cis and trans in the lipid bilayer. Using bifunctional reagents to produce covalent crosslinking of proteins, it has been demonstrated that several major membrane polypeptides exist as oligomeric species. The methodology is currently being refined for study of minor protein components and investigation of appearance and disappearance of aggregates during differentiation.

Another focal point of the research effort concerns the biochemical basis of cellular response to extracellular chemical signals. A specific chemoreceptor protein has been solubilized from the plasma membrane, and its purification is under way. Affinity reagents which react specifically with this receptor have been synthesized with the intent of using such reagents to introduce a covalent, radioactive label into the protein. The techniques of protein crosslinking can then be applied to a study of the aggregational state of the receptor both in vivo and in vitro.

In collaboration with other research groups at M.I.T. and at Harvard and Brown universities, mutant strains of Dictyostelium are being screened for those defective in the chemoreceptor system. Mutants which fail to respond to the chemical signal but which possess the receptor polypeptide are being collected for biochemical analysis.

The study of molecular collisions of various kinds continues in Professor James L. Kinsey's research group. Molecular beam techniques are used in experimental investigations of single-collision chemical reactions as well as non-reactive scattering processes. One such study has focused on the reactions of alkali metals with the halides of cyclic hydrocarbons. The distributions in angle and velocity of the products of these reactions are probed to determine the trends with ring size in energy partitioning and lifetime of the intermediate complex.

A new technique for obtaining extremely detailed information about how a reaction spends its total energy budget in populating product states has been investigated in Professor Kinsey's laboratory. In this method, light from a tunable laser is used to illuminate the region where two molecular beams of reactive substances cross inside a high vacuum apparatus. The wavelength of the light is swept through an absorption band of the product molecule of interest. When the wavelength coincides with an absorption line in the band, the laser will excite fluorescence whose intensity is proportional to the population of the specific quantum state corresponding to the line. This technique has been applied to analysis of the state distribution in the OH radical formed in the reaction of hydrogen atoms with NO_2.

A byproduct of the laser fluorescence work has been an improved determination of the radiative lifetime in the A-X band of OH. Further work exploring the variation of the radiative lifetime with rotational and vibrational quantum numbers is in progress. Some theoretical work involving applications of information theory to the interpretation of detailed rate data is also under way in Professor Kinsey's group.
Professor Karl B. Sharpless is studying oxygenation of organic substances. Although 20 percent of the earth's atmosphere is composed of molecular oxygen (1), practical industrial uses for this inexpensive and powerful oxidant are surprisingly limited. For example, it is not possible to use molecular oxygen (1) for such a simple transformation as propylene (2) to propylene oxide (3):

\[
\text{CH}_2\text{CH} = \text{CH}_3 + \text{O}_2 \rightarrow \text{CH}_2\text{CH} = \text{CH}_2 \text{CH}_3
\]

Propylene oxide (3) is an important monomer for making plastics and polyester fibers. Living systems are superior to chemists in that there are enzymes (oxygenases) which are able to use molecular oxygen for oxygenations such as that shown above (2 3). Our research efforts have been inspired by these natural oxygenases, but before discussing results, briefly consider why the reactions of molecular oxygen are so difficult to control.

Molecular oxygen (1) has long fascinated chemists because it has the rare property of having two unpaired electrons. Most all organic molecules have no unpaired electrons and prefer to react with other molecules which have no unpaired electrons. Thus one encounters the seeming paradox that reactions of molecular oxygen with organic compounds are slow to get started but once started are difficult to control and often lead to explosions and fires. Explosions typically involve runaway reactions in which species with unpaired electrons (e.g., 1) cause chain reactions to occur. Of course the initial barrier to reaction between organic matter and molecular oxygen is very fortunate, for if oxygen had no unpaired electrons we and other organic matter on this planet would literally burst into flames.

Biological systems long ago evolved a means of taming the reactions between molecular oxygen and the organic substances essential to life processes. The solution involves binding the oxygen molecule to an iron-containing enzyme which is similar to the hemoglobin enzyme which transports oxygen in our bloodstream. When bound to such an enzyme, the oxygen molecule no longer has unpaired electrons and the oxygen atoms are smoothly transferred to the biological compounds which are being oxidized. In attempting to imitate these natural processes, we have discovered a number of transition metal oxides which closely mimic the reactions of the oxygenase enzymes. Not surprisingly, one of our best systems to date is, like the biological system, based on an iron complex.

The long-range goal of our research is to develop industrial catalysts which use molecular oxygen to effect selective oxygenations of organic molecules. At present, this can only be accomplished using enzymes. Because such catalysts are not currently available, huge quantities of energy and precious petrochemical feedstocks are wasted each year.

Because of the great practical importance of finding a means of controlling the reactions of molecular oxygen, it has for many years been the object of intensive research by academic and, to an even larger degree, industrial chemists. The problem is clearly a very difficult one, since no solution has been realized. However, in recent years the combined efforts of chemists from several different fields of specialization have led to the emergence of many important new insights.
The student population has remained about the same over the last three years, consisting of 115 graduate students and 70 undergraduate students. The graduate students are distributed in roughly equal parts in the fields of geology and geochemistry, geophysics, planetary science, and oceanography. The number of graduate students receiving no financial support is now about 20 percent, double the figures of two years ago. Undergraduate employment is the Department has decreased from 94 to 53 over the last year. These last two statistics reflect the growing tightness in our extramural research support. Nevertheless, the change in curriculum made two years ago, requiring 12 hours of undergraduate research with the undergraduate degree, is working well. Contrary to predictions made at the time, the Department's research projects have absorbed all of these students with a majority spending considerably more than 12 hours on research.

Curriculum Changes

New or completely revised subjects include the following: an introductory oceanography subject, a subject on the evolution of the earth, an offering in petroleum geology by Visiting Professor James Hedberg, and subjects in the areas of signal analysis and data processing, earthquakes, plate tectonics, and marine geophysics.

Faculty

Dr. Hedberg of the Exxon Corporation spent the fall term here as Crosby Visiting Professor. Dr. John Kanwisher of the Woods Hole Oceanographic Institution (W.H.O.I.) was a Visiting Professor teaching a course in environmental ecology. Professor Mervyn S. Paterson of the Australian National University spent the spring term here filling in for Professor William F. Brace who was on sabbatical leave. Dr. David Davies, who was a Senior Research Associate in our Department for several years, left to become editor of Nature magazine in London. Dr. Michael Chinnery, formerly Professor of Geological Sciences at Brown University, replaced Dr. Davies as Senior Research Associate and director of the Seismic Discrimination Group at Lincoln Laboratory. Professor Richard Naylor left to become chairman of the Department of Earth Sciences at Northeastern University, and Professor Tom McGetchin joined the staff of the Los Alamos Scientific Laboratory. Charles Counselman was promoted to Associate Professor, and John G. Sclater was advanced to the rank of tenured Associate Professor.

Research

Professor Sclater and his colleagues at W.H.O.I. participated in an oceanographic expedition to the Bouvet triple junction at 55°S, 0°E in the South Atlantic. During this expedition the
junction between the African, Antarctic, and South American plates was located and found to be the stable ridge-fault-fault type which is stable in time. From the observations of this junction, the tectonic history of the African-Antarctic ridge for the past 20 million years could be worked out.

From an analysis of satellite photos, Professor Peter Molnar and Visiting Scholar Paul Tapponier discovered several major apparently unknown strike-slip faults in China. Combined with seismic studies and continental reef constructions, the information obtained from the photos allowed them to work out quantitatively what happens when continents collide. They found that in addition to thickening of the crust and uplifting of the surface, crustal shortening can occur in part by a squeezing out of continental material along the newly discovered faults, out of the way of the impinging continents.

Professor Sean C. Solomon and his student Randy Richardson have been working to discover the driving forces for plate motions. By numerically modeling the stress in the lithosphere and comparing their results with intraplate earthquake mechanisms, they have placed great limits on the possible driving forces for plate motions. Their work indicates that very little of the potential driving energy at subduction zones is transmitted as a driving force to the surface plates, and that viscous drag and buoyancy forces at spreading centers appear to be of greater importance than heretofore expected.

Dilatancy forms the basis for most theories of earthquake precursors, in particular the peculiar variation of seismic velocities, now regarded as one of the most promising warning signals. Until this year, however, this explanation lacked direct experimental verification. Kate Hadley, a graduate student working with Professor Brace, was able for the first time to measure the velocities under stress, pressure, and fluid conditions believed to exist at mid-crustal depths. The postulated changes do occur but only under more restricted conditions than usually assumed.

Professor Christopher Goetze has been developing apparatus to observe the high temperature deformation and flow laws for minerals in the earth's deep interior. He has worked out the general flow law for olivine, the major mineral in the earth's mantle. As a byproduct, he discovered a simple, widely applicable law linking paleo-stress with grain size and dislocation density in olivine. This opens up the possibility of determining stresses which rocks were subjected to when they were resident in the upper mantle, and the length of time over which they were deformed.

Professor Keiiti Aki has developed an exciting method for modeling the earth beneath an array of seismographs which has been dubbed "digitizing the earth." His method consists of dividing the earth's crust and lithosphere into a number of blocks and deducing the properties of each block separately from the relative delays of seismic waves arriving at the individual elements of the array. The resulting three-dimensional seismic image of the earth's interior outlines such structures as magma chambers beneath volcanoes, down-going slabs under subduction zones, and deep structure associated with the San Andreas fault of California.

Professor Patrick M. Hurley has been hunting ancient relict continental masses by a randomly spaced regional sampling program of rubidium strontium whole-rock dating of basement rocks. He is interested in outlining rock masses with ages ranging from 3 to 3.8 billion years. He has found an early Archaean region in Liberia and Sierra Leone and another in eastern Venezuela. These two areas were probably contiguous prior to the opening of the South Atlantic.

Professors Frederick A. Frey and John S. Dickey are members of a team, involving W.H.O.I. scientists, which is studying the ocean basement rocks recovered as a result
of deep sea drilling. The results indicate that oceanic island magmas are formed from a mantle that is distinctly different in chemical composition from a mantle which has been parental to the bulk of the sea floor, that is, a sea floor formed from magmas extruded at spreading ridge axes. The general correlation of basaltic geochemistry with tectonic environment is being utilized to understand the complex history of the eastern Indian Ocean.

Professor M. N. Toksoz and his colleagues have been studying seismic velocities in rocks saturated with different fluids (gas, oil, water, steam). These velocities are lower in dry rocks and rocks saturated with gas or steam compared to rocks saturated with water. With these models, and improved field data, it may be possible to determine directly whether a reservoir has natural gas or water. In geothermal energy exploration these results are important for identifying hot dry rocks and steam field. Professor Toksoz also supervised the design and construction of the George R. Wallace, Jr. Geophysical Observatory which was placed in operation this year. He has been named director of this facility, which will be a focal point of our New England seismic network.

Professor Carl I. Wunsch and his student, Ross Hendry, have been able to measure open ocean coherent propagation of the internal tide for the first time, and to deduce the flux of energy. The measurements show that theoretical models of internal tide generation can be used with some degree of confidence and will now permit a worldwide estimate of the rate of transformation of energy from ordinary surface tides into internal waves. The observations indicate that these tides are likely to be important in the mixing budget of the deep ocean, transferring energy at a rate similar to the rate at which work is done on the ocean by wind.

Professor John M. Edmond has been working on the dissolved heavy metals in sea water and has contributed the only valid data currently available for copper and nickel. Concentration levels are between a factor of five and several hundredfold lower than those previously accepted. He has definitely established that both of these metals are involved in the marine biological cycle, and that copper may even be a limiting nutrient. The concentration levels are extremely low (less than one part in a trillion), hence the difficulty in the earlier measurements.

Professor Roger G. Burns and his associates have been investigating the origin and distribution of copper-nickel-rich manganese nodule deposits on the deep sea floor of the Pacific equatorial belt. They have delineated for the first time the host manganese and iron oxide minerals in the nodules, using X-ray emission diffraction, and electron microprobe techniques. They have been able to deduce the locations of copper, nickel, and cobalt in the crystal structures of the manganese oxide materials, and thereby explain the enrichments of these metals in manganese nodules.

Professor Thomas B. McCord and his colleagues at the laboratory for remote sensing have determined the mineralogy and petrology of the surface of about 60 asteroids, and the relationship between the mineral assemblages found in meteorites and those composing the asteroids. They also have obtained critical measurements of the spectral reflectance of regions of the surfaces of Mars and Mercury which are being used to develop the most specific geochemical information available on the surfaces of these planets. The group is continuing its compositional mapping of the moon, and has recently completed a geological map of the Mare Humorum region showing the composition and extent of the surface basaltic units.

Professors Irwin Shapiro and Counselman have developed precise instrumentation to measure crustal strain accumulation in potential earthquake zones by means of radio-interferometric observations of extragalactic objects. One advantage of this measurement technique is that no mutual visibility is required between two points on the earth in order to
determine the baseline vector between them. Another advantage is that all three components of the vector are determined simultaneously. The technique was demonstrated in six experiments, each of about ten hours duration, in which the 1.24 km baseline vector between two antennae of the Haystack Observatory was measured. The mean of the six independent results had an uncertainty of only 2 mm in each vector component.

A new technique of very-long-baseline interferometry has been used to determine the moon's rotation and the positions of radio transmitters on the lunar surface with unprecedented accuracy, within 0.005 seconds of geocentric arc. From the variations which were observed in the moon's rotation, an improved determination of the moon's mass distribution was also made.

Professor Gordon Pettengill has used a new Arecibo S-band radar to obtain reflection of 12.5 cm radar waves from the rings of Saturn. The echo signal was strong enough to permit analysis of polarization showing that the echo was essentially completely unpolarized. Concurrent radar observations at 3 cm wavelength gave similar results and together with the 12 cm results require a particle size distribution that excludes substantial number of ring particles less than a few centimeters in size.

FRANK PRESS

Department of Mathematics

Most of the new subjects offered in the Department of Mathematics this year were in statistics, in line with the rapid build-up of this area within the Department under the direction of Professor Herman Chernoff, the eminent statistician who joined our faculty this year. This spring, Professor Chernoff taught a new undergraduate subject, 18.441 Statistical Inference; it is based on a prior semester of probability theory and makes more use of mathematics than our other two undergraduate statistics subjects. Also this spring, Dr. John Petkau, a newly appointed Instructor, offered for the first time a first-year graduate subject, 18.425 Introduction to Stochastic Processes, and Professors Chernoff and Petkau collaborated on a new advanced subject in statistics. Other new statistics subjects are planned for the coming year.

Several efforts were started in curriculum revision. In the basic sophomore-junior analysis sequence, 18.100-18.101 (of legendary difficulty, throughout the Institute), a preliminary effort was made to attract and hold a wider audience by offering a somewhat less abstract version of 18.100 in both fall and spring, and by offering two versions of 18.101, one oriented toward manifold theory and the other toward Lebesgue integration. All of these new versions were well attended and well received. We will continue to experiment with these next year.

In the applied mathematics group, Professor C.C. Lin experimented with a somewhat altered format and content for 18.042, the basic sophomore survey subject in physical applied mathematics. Professor Lin's revisions, which proved to be very successful, employed a modified case study method augmented by a number of guest lectures. This subject is planned as one of the cornerstones of the program for an applied mathematics degree option currently being developed.
In freshman calculus, 18.01 and 18.02, we added some material on approximations, along with problems best done on hand calculators. The response was largely unfavorable; however, in view of the basic importance of this material in science and engineering, we plan to experiment further next year with ways of making it more palatable.

Faculty

In the area of faculty achievements during the year, at the International Congress of Mathematicians held in Vancouver in August, 1974, three of the 12 one-hour addresses were given by members of the M.I.T. faculty: Professors Victor Guillemin, Daniel Quillen, and Isadore Singer. At the annual meeting of the American Mathematical Society in January, 1975, Professor Quillen was awarded the Cole Prize for his work in algebraic K-theory. This prize is awarded every five years for outstanding research in the field of algebra.

Dr. Julian Palmore, a second-year Instructor in the Department, was appointed a Lilly Teaching Fellow for one year. This is a new postdoctoral teaching program funded by the Lilly Endowment through M.I.T.'s Division for Study and Research in Education. In this first year of the program's operation, the participants were selected on the basis of outstanding teaching ability -- individuals who could play a role in shaping the program for the future.

There were some changes of appointments within the faculty during the year. Professor Gian-Carlo Rota has been named Professor of Applied Mathematics and Philosophy, and will be extending his teaching activities to cover philosophy subjects in the Department of Humanities. Effective July 1, 1975, Associate Professor Steven Orszag is promoted to full Professor with tenure. Assistant Professor Richard Stanley is promoted to Associate Professor. Dr. Yue-Ying Lau is promoted to Assistant Professor of Applied Mathematics, Dr. Edward Miller is promoted to Assistant Professor of Mathematics, and Dr. Andrew Yao is appointed Assistant Professor of Applied Mathematics.

We have had several visiting faculty during the year. Professor Lennart Carleson, director of the Institut Mittag-Leffler and Professor at the University of Uppsala, Sweden, was here for the academic year. Professor Carleson is one of the most outstanding classical mathematical analysts in the world, and his visit -- and the subjects he taught while here -- have helped considerably in our efforts to strengthen Analysis in the Department. Dr. M. Dusa McDuff of the University of York, England, was Visiting Assistant Professor for the year. Dr. Thomas Brylawski, University of North Carolina at Chapel Hill, was a Visiting Assistant Professor during the fall term, and Drs. Nancy Kopell of Northeastern University and William Roberts of the University of Virginia, have been Visiting Associate Professors during the spring semester.

The following faculty members were on leave: for the year, Professors Sigurdur Helgason at the Institute for Advanced Study, Princeton, New Jersey, Elliott Lieb at Princeton University, Gerald Sacks at the Institute for Advanced Study, and George Thomas on personal leave; for the fall, Professors Bertram Kostant at the University of Paris, Curtis Greene at the University of Pennsylvania, and Norberto Kerzman as a Sloan Fellow; for the spring, Professors Isadore Singer at the Courant Institute, and Alar Toomre at California Institute of Technology.
Publications

Several books authored by members of the faculty have come out during the year:
*Differential Topology*, by Professor Guillemin and Alan Pollack; *Mathematics Applied to Deterministic Problems in the Natural Sciences*, by Professor Lin and L. A. Segel; *Analysis in Euclidean Space*, by Professor Kenneth M. Hoffman; and *Topology: A First Course*, by Professor James R. Munkres.

KENNETH M. HOFFMAN

Department of Meteorology

Belying its name, the Department is as much concerned with physical oceanography as with meteorology, and for this reason it is uniquely qualified to conduct teaching and research in the central problems of climate and climatic change which involve the atmosphere and oceans as physically coupled, dynamically similar systems. This unity, intellectual as well as physical, was emphasized by the introduction of a new subject on turbulence and boundary layer phenomena in the atmosphere and oceans by Professor John E. Hart, and by the amalgamation of Professor Henry M. Stommel's subject on large-scale ocean circulations with Professor Jule G. Charney's offering on planetary fluid dynamics to form a single, jointly-taught, two-term subject on large-scale ocean and atmospheric dynamics. The concern with climate and climatic changes was the motivation for Professor Peter H. Stone's reconstitution of the offering on the general circulation of the atmosphere as a logical two-term sequence with his subject on atmospheric models. Another change was occasioned by Professor Henry G. Houghton's retirement from teaching. The material of his subject, 19.72 Physical Meteorology, pertaining to cloud physics, will be covered by Senior Research Associate Pauline M. Austin in her revised offering on atmospheric precipitation processes, and the material on radiation physics will be included in Professor Ronald G. Prinn's subject on atmospheric radiation.

Enrollment

Graduate student enrollment in meteorology and oceanography remained about constant with 52 students registering in fall, 1974, but is expected to jump to 63 or more in fall, 1975, because of an increase in applications and greater certainty in research funding. Six women students were enrolled during the year, and a second American black student will enroll in the fall.
Faculty

The year's end saw the resignation of Associate Professor of Oceanography Robert C. Beardsley, and the appointment of Assistant Professor of Meteorology Eugenia Kalnay de Rivas. Richard S. Lindzen, Gordon MacKay Professor of Dynamic Meteorology at Harvard University, was a Visiting Professor during the spring term; Edwin Kessler III, Director of the National Oceanographic and Atmospheric Administration's (NOAA) National Severe Storms Laboratory will be a Visiting Professor next fall; and Arnt Eliassen, Professor of Geophysics at the University of Oslo, will be a Visiting Professor next spring.

After 47 years of faithful service to M.I.T., Emeritus Professor Henry G. Houghton retired from teaching on June 30, 1975. His distinguished career in research and teaching began in 1928 when he became a research associate in electrical engineering and assistant to Julius Stratton. His early work on the microphysics of fog and clouds attracted wide attention and has remained a model for such work in cloud physics. Later he went on to study weather modification and control and the radiation balance of the atmosphere as well as other aspects of cloud physics. In 1945, he became Head of the Department and continued in that capacity until his retirement in 1970. Under his leadership, the Department grew and became by any measure the leading department of meteorology in the country. Professor Houghton's influence extended well beyond the confines of M.I.T. His wise and balanced judgment was sought by many government and professional organizations. He became president of the American Meteorological Society and president of the Section on Meteorology of the American Geophysical Union. As chairman of the Board of Trustees of the National Center for Atmospheric Research, he played a major role in guiding its first years of growth. The Department is grateful to him for all he has done and wishes him a happy retirement.

Research

Despite its small size (11 full-time faculty), the Department has participated significantly in a wide variety of national and international research programs as well as in individual research activities. Among the former may be mentioned:

POLYMODE. Professor Stommel initiated the concept of the Mid-Ocean Dynamical Experiment (MODE I). After its successful completion in 1973, he and Professor Allan R. Robinson of Harvard University proposed and began the initial planning of POLYMODE, a joint U.S./U.S.S.R. ship-buoy program to be carried out in the western North Atlantic. The main field effort is intended to give information about the geographical distribution of the highly energetic mesoscale eddies studied in MODE I, and about their interaction with the mean ocean circulation. The findings of MODE I have already encouraged a spate of theoretical and numerical studies which are intended to shed light on the character of the ocean circulation.

INDEX. In spring, 1975, Professor Stommel and other scientists conducted pilot experiments in the Indian Ocean (INDEX) aimed at discovering how the Indian Ocean circulation responds to the monsoon winds. Efforts to monitor the equatorial currents and counter-currents at two longitudes were carried out from the Maldives and Seychelles islands.

MONEX. The Global Atmospheric Research Program (GARP), sponsored jointly by the World Meteorological Organization and the International Union of Geodesy and Geophysics,
includes a plan for measuring the large-scale motions of the entire global atmosphere in 1978-79. At the same time there will be a regional study of the Asiatic monsoon (MONEX). In connection with MONEX, Professor Stommel has embarked on a climatological study of ship reports for the past 100 years in the Indian Ocean to see if a relationship can be established between sea temperatures and the strength of the monsoon over India. Preliminary evidence indicates that such a relationship exists. His work provides empirical support for graduate student, Dr. Jagadish Shukla's study which shows, by means of a numerical model of the general circulation of the atmosphere, that changes in sea surface temperature in the Arabian Sea off Somalia can have a marked effect on monsoon rainfall over India.

GATE. The Global Atmospheric Research Program was originally proposed by Professor Charney in 1961. Later, as chairman of the Panel on International Cooperation of the U.S. National Academy of Sciences' Committee on Meteorology, and as chairman of the Academy's Committee for GARP, he also proposed an international program to measure the organization of cumulus convection in tropical circulation systems. This program was carried out in summer, 1974, as the GARP Tropical Atlantic Experiment (GATE). Taking part were Senior Research Associate Austin and Professor Erik L. Molland-Christensen. Dr. Austin and her associates installed a five centimeter radar and digital data processing system in the research vessel James M. Gillis with which almost continuous measurements of the three-dimensional distribution of precipitation were made during the third phase of GATE. Professor Molland-Christensen's hydroglider was used from the R-V Columbus Iselin during the third period of GATE for observations of the small-scale physical processes that determine the structure of the upper ocean. More than 500 profiles of the oceanic surface layer were measured. In appreciation of the contributions of Department members to the success of the GATE project, a special commendation was given to the Department by the Administrator of NOAA.

CIAP. In connection with the U.S. Department of Transportation's Climate Assessment Program (CIAP) to assess possible effects of supersonic transport (SST) emissions of nitrogen oxide on the ozone concentration in the stratosphere, Professor Ronald G. Prinn and Research Associates Derek M. Cunlold and Fred N. Alyea continued the development of their three-dimensional atmospheric circulation model by incorporating more detailed ozone photochemistry. The model successfully simulates the observed seasonal and latitudinal variations of atmospheric ozone. Their work had an important influence on the final governmental assessment and on an independent assessment by the National Academy of Sciences. Their model is now being used for studying the effects on the ozone layer of hydrochloric acid emissions by the Space Shuttle and of chlorfluoromethanes (freons) from spray cans.

Professor Edward N. Lorenz extended his theory of the predictability of the atmosphere and similar non-stationary fluid systems so as to make possible the determination of what constitutes the best possible forecast, and at what point further improvements in forecast practice cease to be worth the effort to produce them. He also continued to lay the groundwork for a theory of the predictability of climatic change, by considering systems permitting long-term fluctuations.

Useful models for the study of climate and climatic change may be constructed by perturbing the quasi-stationary flows that would exist with slowly varying boundary conditions in the absence of hydrodynamic instabilities. Such studies have been carried out by Professors Charney, Stone and others, when the stationary flow consists of an axisymmetric, circum-polar vortex. It is more difficult to calculate non-symmetric stationary flows whose instabilities cannot be eliminated by symmetry constraints. Following a suggestion by Professor Charney that a scheme used for eliminating high frequency gravity-wave noise in numerical prediction models might be adaptable to this problem, Professor Rivas devised a method of great power and simplicity which is expected to give considerable impetus to the dynamical investigation of climate.
For his part, Professor Stone extended his treatment of simple climate models based on perturbations of axisymmetric flows to include stratospheric as well as tropospheric interactions. He also collaborated with scientists at the National Aeronautics and Space Administration's Goddard Institute for Space Studies (GISS) in New York City, in numerical climate investigations.

Professor Charney continued his study of desert–monsoon circulations in collaboration with Professor Stone and Dr. William J. Quirk of GISS. Numerical experiments with the GISS general circulation model verified Charney's conjecture that a positive biogeophysical feedback mechanism exists at desert margins whereby a reduction of vegetation causes increased surface reflectivity to solar radiation, increased radiative cooling, increased sinking and drying of the air, decreased rainfall and, therefore, a further reduction of vegetation. Investigations are now under way to determine the extent to which the recent drought in the Sahel, the droughts of the 1930s and 1950s in the western Great Plains of the United States, and the historical decrease of rainfall and vegetation in the Thar Desert of India were due to such a mechanism. The potential importance of the preliminary results for food production gave impetus to a conference held at Endicott House in which Department scientists conferred with agriculturalists and agricultural economists to consider how new results from dynamic climatology may be applied to landuse planning for the increase of food production.

Professor Reginald E. Newell's group made a detailed study of the recent African rainfall patterns to create a more concrete basis for discussion of the space-time variability of rainfall in the Sahel. The group also made an estimate of the global rainfall for 20,000 years ago from palaeoclimatic reconstructions and showed that it was smaller than at present by about ten percent. Professor Newell and Minoru Tanaka, a graduate student in the group, ran a workshop on climate and food in the January, 1975, Independent Activities Period in which they paid particular attention to the yield of wheat in the U.S.S.R. as it is influenced by climatic variability; rice yields of India and Japan were also examined, the latter as an example of the minimization of the effects of climatic variability by means of irrigation.

Professor Prinn continued his research on the chemistry, physical structure, and evolution of planetary atmospheres. His prediction that the visible clouds that completely shroud Venus would consist of concentrated sulfuric acid has now received strong observational confirmation. He and Professor John Lewis of the Department of Earth and Planetary Sciences are completing an extensive model for solar system evolution which can explain essentially a priori the observed bulk composition of the atmospheres of the planets and Titan. They also are studying the photochemistry of ammonia and the recently discovered phosphine on Jupiter, with particular emphasis on photochemical production of hydrazine and red phosphorus particles. They have proposed that there are three levels of clouds on Jupiter: the top consisting of colorless ammonia, the middle of ammonium hydrosulfide, which turns yellow in sunlight, and the bottom of water vapor and ammonia. They explain the light orange and red spots as red phosphorus which is formed when a storm quickly carries phosphine up above the clouds of ammonia where ultraviolet radiation turns it into red phosphorus.

The dynamics of planetary atmospheres were studied by Professors Stone and Rivas. Professor Stone directed theoretical research on seasonal changes on Mars and analyzed Pioneer 10 data for dynamical information on Jupiter. He was chosen a member of the photochemistry experiment team for the Pioneer Venus Orbiter Mission. Professor Rivas continued her dynamical research on the Venus circulation to include the asymmetries that are believed to be responsible for the so-called four day rotational period of the upper Venus atmosphere.
Honors and Awards

The Department continues to receive its share of honors. Professor Edward N. Lorenz was elected to the National Academy of Sciences, making him the third among eight tenured faculty to be so honored. Professor Stommel received the Sixth Bigelow Medal of the Woods Hole Oceanographic Institution for outstanding accomplishments in physical oceanography. Dr. Stommel was recognized for "his complex and multi-dimensional approach to the world's ocean problems." Dr. John V. Evans, a member of the Lincoln Laboratory and a Senior Lecturer in the Department, was awarded the Appleton Prize for 1975 of the Royal Society of London "for distinguished contributions to the field of ionospheric physics, in particular for his leadership in applications of the incoherent scatter technique in studies of the physical characteristics and the dynamics of the ionosphere." Bijoy Misra, a graduate student, received the World Meteorological Organization Research Award for an outstanding research paper written by a young scientist working in the field of meteorology in a developing country.

Jule G. Charney

Department of Nutrition and Food Science

The research and educational activities of the Department continued to grow, as seen in the numbers of postdoctoral associates, of graduate students, and of undergraduates. During the past year the Department carried out a review of policy objectives and future planning initiated during a meeting held at Endicott House in March, 1974. Subsequently, task forces composed of faculty and students prepared reports examining future goals and recommending actions leading toward their achievement in the following areas:

- development of graduate education and research in food science and technology and biochemical engineering;
- development of graduate education and research in nutritional biochemistry and metabolism and toxicology; and
- development of the Department's undergraduate program.

The task force reports were reviewed at a Departmental meeting held at Endicott House in March, 1975, and were incorporated into the report to the Visiting Committee. A number of the recommendations have already been implemented, and others will be during the coming year.

The level of funding remained stable with a relatively constant total dollar volume, but the distribution of funds among different areas of the Department has equalized. In particular the funding of faculty in food science and technology, which was a cause of concern in 1973, has shown substantial improvement during the past year. The inflationary pressures on the cost of research have meant that fewer research assistantships can be funded from the same volume of funding. Nevertheless, the Department has increased graduate student enrollment substantially, by an increase in students supported with their own funds, by individual fellowships from various U.S. sources, and through fellowships granted by foreign governments and international agencies.
Undergraduate Education

The undergraduate curriculum in Applied Biology, Course VII-2 is continuing to expand. In spring, 1975, there were 94 undergraduates enrolled in the program and 21 students graduated in June, 1975. In addition, the participation of the faculty of the Department in various other advisory activities involving undergraduates has been increasing as shown in the following table:

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of UROP Students</th>
<th>Number of Freshman Seminars</th>
<th>Number of Freshman Advisors</th>
<th>Pre-Med Students Advised</th>
<th>VII-2 Students Advised</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971-72</td>
<td>34 Fall 56 Spring</td>
<td>2</td>
<td>12</td>
<td>65</td>
<td>11</td>
</tr>
<tr>
<td>1972-73</td>
<td>60 Fall 86 Spring</td>
<td>8</td>
<td>9</td>
<td>39</td>
<td>25</td>
</tr>
<tr>
<td>1973-74</td>
<td>103 Fall 102 Spring</td>
<td>6</td>
<td>6</td>
<td>42</td>
<td>55</td>
</tr>
<tr>
<td>1974-75</td>
<td>100 Fall 105 Spring</td>
<td>11</td>
<td>10</td>
<td>45</td>
<td>94</td>
</tr>
</tbody>
</table>

Undergraduate research opportunities will be available during the summer. Recently, a National Science Foundation Undergraduate Research Participation Program grant was awarded to Dr. Charles L. Cooney and other co-principal investigators. This grant will allow undergraduates to participate in research projects. Presently, this is the only NSF/URP award for undergraduates at M.I.T., and it is the fourth consecutive year that the Department has received such an award. The faculty has continued to promote high quality research by UROP students through symposia on undergraduate research which are held biannually and through encouragement of the publication of scientific papers co-authored by undergraduates.

Undergraduate enrollment in Course XX subjects has also continued to grow, and in 1974-1975, was a major contributing factor in the 19.7 percent increase in total credits earned in subjects offered by the Department.

Graduate Education

Our graduate student enrollment increased from 113 in September, 1973 to 139 in September, 1974. The curriculum committees of the Department have monitored, evaluated and reorganized the graduate curricula. A major feature of these efforts has been the heavy involvement of students. All of the curriculum task forces, committees, and discussion groups have student representatives. Major efforts at improving several aspects of our educational program are under way. These include:

- reorganization of the system of course evaluation by students;
- reorganization of the toxicology curriculum; and
- review of the doctoral examination system.
Symposia and Summer Courses

On October 1, 1974, the Twelfth Annual Underwood Prescott Memorial Lectureship was presented to three scientists for their achievements in space food developments. Dr. Paul Rambaut and Dr. Norman D. Heidelbaugh were the first M.I.T. alumni to be so honored. Both received doctorates from the Institute in 1966 and 1970, respectively. They shared the award with Dr. Malcolm Smith, Jr., Chief of the Food and Nutrition Branch of the Lyndon B. Johnson Center of the National Aeronautics and Space Administration. The work for which the three men were honored was conducted at the Center. A symposium on "Feeding and Human Nutrition in Space" was held at the Museum of Science in Boston on the occasion of the presentation of these awards.

Five one-week summer school subjects were given during summer, 1974, and were attended by industry, government, and university scientists. These programs help the Department keep in close contact with these scientists. A listing of subjects and their attendance follows:

1) Current Concepts and Techniques in Experimental Pathology and Toxicology of Natural and Man-Made Agents was directed by Professor Paul M. Newberne. It was attended by 52 persons.

2) Enzymes and Their Use in Analysis and Clinical Diagnosis was directed by Professor George Wolf. It was attended by 40 persons.

3) Advances in Human Nutrition Knowledge was directed by Professor Vernon R. Young. It was attended by 35 persons.

4) Properties and Reactions of Foods: Nutritional and Quality Implications was directed by Professor Marcus Karel. It was attended by 43 persons.

5) Fermentation Technology was directed by Professor Daniel I.C. Wang. It was attended by 65 persons.

In summer, 1975, five subjects will be offered:

1) Enzymes and Their Use in Analysis and Clinical Diagnosis will be directed by Professor Wolf.

2) Advances in Human Nutrition Knowledge will be directed by Professor Young.

3) Fermentation Technology will be directed by Professor Wang.

4) Engineered Foods: Technological, Nutritional and Marketing Implications will be directed by Professors Samuel A. Goldblith and Karel.

5) Current Concepts and Techniques in Experimental Pathology and Toxicology of Natural and Man-Made Agents will be directed by Professor Newberne.
Clinical Research Center

The year has been one of continued extensive utilization of the Clinical Research Center by the Department of Nutrition and Food Science. In addition many patients have been studied by the staffs of other departments at M.I.T. and at some of the neighboring Cambridge hospitals by individuals on our staff. Dr. Hans-Lukas Teuber and his colleagues in the Department of Psychology have continued their studies of individuals with various kinds of cerebral damage. Dr. Ronald Arky, Head of the Department of Medicine at Mount Auburn Hospital, has been investigating diabetics, especially those with obesity, on various regimens for weight reduction. Dr. George Blackburn and his colleagues have been particularly active in their long-term work with surgical patients, obesity, and other conditions, with considerable recent emphasis on immune status. Dr. Nevin S. Scrimshaw and his students have been studying a variety of new foods and have contributed particularly to our knowledge of minimum protein requirements. Dr. Charles S. Davidson, who became program director of the Center on January 1, 1974, continues to study patients with liver disease in collaboration with a full-time colleague, Dr. Birgitta Hammarstrom, and in collaboration with Dr. Richard Wurtman and his colleagues. Dr. Robert Lees and his colleagues continue to use the Center for study of their patients with hyperlipidemia.

One of the areas in which investigation has become concentrated by a number of groups is the relationship between nutrition, certain diseases, and various parameters of immunity, particularly of cellular immunity. Dr. Robert Suskind, who is associate director of the Center, has planned an active program of research and training, with a new and exciting program shortly to get under way in affiliation with the Children's Hospital Medical Center in Boston. This will enhance our pediatric interests at the Center and bring some new and exciting minds to bear on the research. Dr. Suskind also will be responsible for the training of several young people. This will certainly expand the importance of the Center.

With the assistance of Professor William M. Rand, a PDP-12 computer has been used to improve data storage and retrieval. A considerable number of new computer programs have been written so that it is now possible to get data presented rapidly and, as a rule, in a form in which it is most useful to the investigator.

The core laboratory received a Gilford Spectrophotometer and an Auto Technicon which have greatly enlarged its operating ability. This year the core laboratory completed 31,849 determinations, including 599 urinalyses, 4,042 hematology studies, and 27,208 chemical analyses. The specimens laboratory has processed more than 6,000 urine and stool collections and prepared them for analysis.

Approximately 23 active projects have been undertaken at the Center during the past year. There were 225 admissions for a total of 2,837 days of patient care, and 714 outpatients were seen in 3,138 visits. There were no deaths during the year.

Faculty

Promotions within the Department during the past year were Dr. Maria C. Linder to Associate Professor of Physiological Chemistry and Dr. Cooney to Associate Professor of Biochemical Engineering. New appointments during the past year were Dr. Mac V. Edds, Professor of Neurobiology and executive director of the Neurosciences Research Program; Dr. Lance Taylor, Professor of Nutritional Economics (a joint appointment with the Department of Economics); Dr. Suskind, Associate Professor of Pediatrics and Clinical
Nutrition and associate director of the Clinical Research Center; and Dr. Peter Rogers, Visiting Associate Professor of Biochemical Engineering. Faculty members leaving were Associate Professor Ronald Shank and Visiting Professor Alan D. Berg, who will continue as a Visiting Lecturer.

Honors and Awards

Dr. Michael C. Archer, Assistant Professor of Biological Chemistry, received the 1974-76 Nutrition Foundation Future Leaders Award; Dr. Arnold L. Demain, Professor of Industrial Microbiology received the 1975 Waksman Award from the Theobald Smith Society (the New Jersey branch of the American Society for Microbiology); Dr. John D. Fernstrom, Assistant Professor of Nutritional Biochemistry and Metabolism, received an Alfred P. Sloan Fellowship in Neurochemistry for 1974-76; Dr. Goldblith, Underwood-Prescott Professor of Food Science and Director of Industrial Liaison, was elected a Fellow of the Institute of Food Science and Technology of the United Kingdom (1974); Dr. Scrimshaw, Professor of Human Nutrition and Head of the Department was honored with the American Public Health Association Award for Excellence in October, 1974, and the McCollum Award of the American Society of Clinical Nutrition; Dr. Anthony J. Sinskey, Associate Professor of Applied Microbiology received the Prescott Award for Research of the Institute of Food Technologists; Dr. William G. Thilly, Assistant Professor of Toxicology received the Lilly Endowment Teaching Award for September, 1974, through June, 1975; and Dr. Wurtman, Professor of Endocrinology and Metabolism, received the Foster Elting Bennett Lectureship of the American Neurological Association for 1974.

The 1973-74 Graduate Teaching Award for Food Science and Technology was presented by the graduate students of the Department to Dr. Demain, Professor of Industrial Microbiology; and the Graduate Student Teaching Award for Nutritional Biochemistry and Metabolism was presented to Dr. Shank, Associate Professor of Food Toxicology. The 1974-75 Graduate Teaching Awards were presented to Dr. Karel, Professor of Food Engineering and to Dr. Sanford A. Miller, Professor of Nutritional Biochemistry.

NEVIN S. SCRIMSHAW
MARCUS KAREL

Department of Physics

This has been an extraordinarily successful research year, perhaps the most successful in the history of the Department of Physics. There have been not just one, but many discoveries and accomplishments which had and will continue to have major impact. A few of these include:

* These researches were performed under the aegis of the interdepartmental laboratories. Alcator developments involved members of other departments.
Department of Physics

- the discovery of the 'J' particle;
- the absence of cascading in the interaction of a very energetic pion with a nucleus;
- a model for hadrons;
- the successful operation of the Bates Linear Accelerator facility producing high energy electrons for the study of the properties of nuclei;
- the successful operation of the Alcator, a device producing a toroidal plasma of high temperature and density; and
- participation in the Mercury 10 satellite project as well as the successful launching of the SAS-3 satellite.

Each of the above is described in the reports of the various divisions of the Department. These successes, together with the many others mentioned in the reports of the divisions, have great promise for the future as consequences are investigated and new insights delineated.

As mentioned in last year's report, a serious study of our undergraduate educational program led to a number of recommendations which we are now trying to put into force. For example, the undergraduate physics complex is being developed. The undergraduate physics common room was established this year and has already proved a focal point for student-faculty involvement. There is a weekly undergraduate colloquium and an undergraduate newsletter. The whole advisory apparatus has been made more responsive and effective. The undergraduate thesis is being started earlier, and faculty participation in the undergraduate laboratories has been substantially increased. The faculty as a whole has shown an extraordinary spirit and devotion to this effort which I am certain will have a strong beneficial effect on the educational experience of undergraduate M.I.T. physics students.

In the course of the last year, similar considerations have been developed regarding our graduate program, where breadth is deliberately encouraged. A mechanism to provide a better correlation of graduate subjects has been instituted, and a more helpful advisory system for the graduate student has been created. Nevertheless, a great deal remains to be done, and some of these reforms, of course, have not been in force for a sufficient amount of time to permit evaluation.

One of the events that should be singled out for comment is the "festival" in honor of Professor Victor F. Weisskopf held on October 17 and 18 of this academic year. Included in the program was a musical evening involving members of the Department of Physics, particularly Professor Weisskopf, together with Eric Rosenblith of the New England Conservatory of Music. An unusually distinguished list of notables came to participate and to deliver addresses. The speakers included: Hans Bethe, Julian Schwinger, Edward M. Purcell, Tsung Dao Lee, Murray Gell-Mann, Ben R. Mottelson Stanislaw M. Ulam, Max Delbruck, Wolfgang K.H. Panofsky, David Hawkins, H.G.B. Casimir, and Valentine L. Telegdi.

**Experimental Nuclear and Particle Physics**

The research activities of the members of the Division of Nuclei and Particles have continued to be very active and productive despite the continuing pressure of budgetary stringencies. Research and technical development were carried out in the broad fields of

* For a more extensive discussion, also see the report of the Laboratory of Nuclear Science, under whose aegis much of the research of members of the division is carried out.
School of Science

nuclear reactions and heavy ion physics, of medium energy physics, and of high energy particle physics. Notable accomplishments and results were achieved this year in many aspects of the overall program; among the highlights are the following:

1) **Nuclear Reaction and Heavy Ion Physics.** An experiment at Brookhaven National Laboratory on the fusion of heavy ions which led to the discovery of a complete series of resonant states in the collision of carbon nuclei upon carbon nuclei. These states have been seen up to very high angular momenta and may open up a qualitatively new class of collective nuclear structures.

2) **Medium Energy Physics.** The Bates Linear Accelerator has been operating regularly since June, 1975, with the rate of stable operations approaching 3,000 hours/year. Reliability and improvements are still being worked on, but the machine can be considered a stable research tool for energies up to 300 MeV. The main limitations at present being the availability of high power tubes for the R.F. In the past year a total of 1,150 hours of beam time has been delivered to physics experiments including photo-pion and photo-nucleon studies and electron scattering. A large amount of beam time was used on the study of rotational states in deformed nuclei using electron scattering, in extension of earlier work done at the National Bureau of Standards. The instrument that is used for these studies is the high resolution 250 ton energy-loss spectrometer \( \Delta E/E \approx 10^{-4} \). Electron scattering data have been acquired on many nuclei revealing many heretofore unobserved states and new structures which are currently under analysis. An experiment on photo-proton production has begun to give results which bear on the high momentum components of nuclear wave functions. A study of pion production from nuclei has been undertaken. The first experimental results in the region just above threshold indicate that the theory of this fundamental process is approximately correct. These measurements probe the coupling of nucleons to the pion field in complex nuclei, an interaction which is fundamental to our understanding of the nuclear force.

3) **High Energy and Particle Physics.** The various groups are all in the data acquisition and analysis phase of several experiments directed toward elucidation of elementary-particle dynamics and systematics. This work is proceeding at most of the major accelerators around the world. An experiment at Brookhaven National Laboratory on heavy meson formation and mu-electron universality bore fruit with the spectacular discovery of the narrow 'J' particle, the first in a series of new and unexpected particles whose properties still elude classification. Another experiment on the study of the multiplicity distribution of particles produced in collisions with nuclei gave the remarkable result that there is no multiplication of the fast forward projectile fragments in such collisions, and may indicate that the final multiparticle state takes a long time to develop. An experiment utilizing a bubble chamber and auxiliary electronic detecting equipment to tag particles in a study of diffractive excitations of hadrons gave very interesting results, that is, the measured data are clearly inconsistent with all current nova, or two fireball models, and some other mechanism must be responsible for the dynamics of these high energy peripheral collisions. A collaborative experiment on the ratio of positive to negative meson production in inelastic electron
scattering performed at the Stanford Linear Accelerator has given evidence that may be interpreted as favoring the existence of fractional electric charges for the substructure partons within the nucleon. Finally, a definitive experiment on elastic and quasielastic scattering of hadrons at Fermi National Accelerator Laboratory has shown that the effective diffraction disk for K+ mesons and protons gets larger and that of anti-protons gets smaller. Pi- mesons and K- mesons seem to have an unchanging diffractive disk diameter throughout this energy region.

Center for Theoretical Physics*

Particle Theory

In particle theory, work has continued on the development of the "M.I.T. Bag Model." Invented a little over a year ago, this is a model of extended elementary particles which incorporates many of the features of earlier quark-parton and dual models. This year several calculations have been made, using the model, which relate to different aspects of particle structure. The results have been very encouraging.

An approximation scheme has been developed in order to calculate the spectrum of the highest SU(3) multiplets of hadrons. These include the two meson nonets and the baryon octet and decuplet. By including the effects of the quark-quark interaction to the lowest order, and quantum fluctuation effects, a great improvement on the earlier results has been obtained. The magnitude of the quark-gluon coupling constant is determined by these calculations.

Studies have been made of the deep inelastic structure functions within the same approximation scheme and these are in good general agreement with the form of the observed functions.

A model of the elastic scattering at high energies of extended hadrons composed of quarks coupled by colored gluons has been shown to have many general features in agreement with the observed elastic scattering amplitudes. These calculations provided an estimate of the coupling constant which is in agreement with the one obtained from the mass spectrum.

Investigations of how extended particle models may be developed from conventional local field theory have been made. These ideas are related to classical non-linear stationary waves ("solitons"). Computations have been made to see how quantum effects can be included in such classical solutions to non-linear field equations. Some of the features present in the nuclear many-body problem are also present in this approach to the description of elementary particles.

* For a more extensive discussion, also see the report of the Laboratory for Nuclear Science, under whose aegis much of the research of members of the division is carried out.
Nuclear Theory

With the advent of meson factories and high resolution electromagnetic probes of nuclei, considerable effort has been devoted to understanding the nucleus as a quantal many-body system comprised of mesons and excited baryons as well as ordinary nucleons. The propagation of pions in nuclei has been investigated in terms of multiple scattering theory, with particular attention to two especially tractable applications: pion-deuteron scattering and pions and infinite nuclear matter. Other related work has dealt with propagation of pion-nucleon resonances in nuclear matter, pion photo-production, meson theory of the nucleon-nucleon force, exchange current effects in electromagnetic interactions, and a relativistic Hartree-Fock theory of both ordinary and "abnormal" states of nuclei.

The formulation of a microscopic theory of collective motion is a general problem of quantum mechanics which is particularly relevant to nuclear physics due to the rich experimental manifestations of collective behavior. New techniques, such as the use of Feynman path integrals and time-dependent variational principles, have been developed. The time-dependent Hartree-Fock theory has been investigated in the adiabatic limit, and has been solved numerically for the special case of systems with one-dimensional geometry. The relation of this theory to the generator-coordinate theory and to hydrodynamics has been investigated, and a wide range of applications, including heavy ion reactions, fission, and moments of inertia, have been treated.

Nuclear structure investigations have continued to try to predict the structure of finite nuclei and to test these predictions with a variety of nuclear probes and reactions. Microscopic Hartree-Fock calculations for spherical and strongly deformed nuclei yield systematic agreement with nuclear density distributions as measured in elastic and inelastic electron scattering experiments, muonic atoms, and high energy proton scattering. Microscopic calculation of excited states and spectra is much less successful, so continued effort has been devoted to attempting to understand the effective interaction appropriate to the shell model. A variety of problems in scattering theory has been studied, ranging from such topics as pre-equilibrium reaction theory and tests of the statistical theory of nuclear reactions in crystal channeling experiments, to high energy problems such as proton scattering from nuclei at 1 GeV and the collisions of relativistic heavy ions.

Astrophysics Division*

The astrophysics program in the Department has continued its broadly-based research efforts, spanning the entire electromagnetic spectrum from radio wavelengths to X rays. The major "spectaculars" of the past year were the successful launch of the M.I.T. X-ray satellite, SAS-3, and the successful encounter of Mariner Venus-Mercury with the planet Mercury, carrying an M.I.T. plasma experiment. In addition, our electrical engineering colleagues are celebrating the launch of an M.I.T. radio astronomy experiment for earth atmosphere studies on NIMBUS-6.

The X-ray experiments on SAS-3, which was launched from the San Marcos platform off the coast of Kenya in early May, are all working perfectly, and in the brief time since experiment turn-on, several interesting discoveries have been made. Just before the launch, a

* For a more extensive discussion, also see the reports of the Center for Space Research and the Research Laboratory of Electronics, under whose aegis much of the research of members of the division is carried out.
new X-ray source suddenly appeared, and the SAS-3 observations immediately showed that the spectrum was extraordinarily energetic, with unusually great intensity at the highest energies. In addition, the source varied in a complicated fashion with 103-second periodicity. Shortly afterwards, another X-ray source, 3U-0900-40 was shown to have a periodicity of 283 seconds, and it appears that an entirely new class of periodic source, slower than pulsars but more rapid than the known orbiting X-ray sources, has been discovered. The satellite carries a variety of experiments to give spectral information on X-ray sources from 100 volts to tens of kilovolts, and will measure X-ray source positions to a few seconds of arc, thus allowing positive optical identification even if the associated optical object is very faint. Analysis of X-ray data from OSO-7 has shown a completely new class of X-ray sources, residing as members of globular clusters. Since globular clusters are thought to be aggregates of the very oldest stars, well evolved and with very little associated dust and gas, energetic phenomena were not expected. Collaboration with the M.I.T. radio astronomy group was immediately established to see if the globular cluster X-ray sources are radio sources as well.

The Mercury encounter gave most unexpected results. Mercury turns out to have a permanent magnetic field and a magneto plasma whose boundaries and bow shock were demonstrated by the M.I.T. plasma experiment. The interaction of Mercury with the solar wind has turned out to be entirely different than that of the Moon or Venus, contrary to expectations. The near future will see an M.I.T. plasma probe on the Mariner mission to Jupiter and Saturn.

Balloon and rocket experiments in X-ray astronomy continue to play a role because of the short response time that such vehicles afford. A rotating modulation collimator flown on a rocket has mapped the Cygnus loop, a supernova remnant that has long been known as a radio source and whose physical conditions can be understood much better when X-ray and radio data are combined. A balloon flight from northern Canada was successfully coordinated to coincide with an occultation of the Crab Nebula by the Moon. Balloon equipment observes X-rays at energies of 25 kilovolts and above because of the blanketing of the earth’s atmosphere, but the exposure times are much longer than those available from rocket flights. The observations demonstrated that the high energy X-rays are not distributed in the Crab Nebula in the same way that lower energy X-rays are, but come from an elliptical region perpendicular to the major axis of the nebula, displaced from the pulsar and apparently related to the light wisps that are believed to be hydromagnetic waves generated by the action of the pulsar.

Our high energy theoretical work has concentrated on X-ray source and pulsar and quasar theory. Exploration is continuing of the consequences of both the spinner and the "gravitational slingshot" theory of quasars in which the essence of the approach is to rely on conventional gravitational effects as the source of energy for the quasars. Theoretical analysis of the X-ray observations of sources has led to the discovery that the varying source Herc X-1 has a remarkably uniform pulse shape that can be used to support a particular model of the source. Pulsar studies recently received a new impetus by the discovery of a binary pulsar with an extraordinarily small major axis. The relativistic celestial mechanics of the system have been analyzed with the conclusion that the procession of the parahelion was consistent with general relativity to sufficient accuracy to rule out several classes of stars such as white dwarfs as the companion.

Radio astronomy was marked by a number of successes in very long baseline interferometry (VLBI). The method has been used to measure radio source positions and geodetic distances. It has been demonstrated that the distance between our telescopes on the earth can be measured with 30 cm accuracy, and further improvements in accuracy are expected eventually to yield the direct measurement of continental drift. Astrometric measurement of quasar position
School of Science

now is equal to the best that optical astronomy can do and further improvements in accuracy also are expected. The properties of celestial maser sources have been extensively studied. Recent work has shown that magnetic fields of the order of \(10^{-4}\) gauss are certainly present in some of the sources. A synthesis of the observations has suggested a schematic evolutionary pattern in which the water vapor masers appear at the very earliest stages of star formation followed at a later stage by the appearance of hydroxyl masers. The aim of the program is to obtain a large scale picture of star formation throughout the galactic system. Maser action has been shown to occur for metho-alcohol radiation. During these investigations a curious fine structure has been observed. It was shown that this fine structure is caused by Doppler shift rather than molecular interactions or Zeeman effect.

The infrared part of the spectrum covers a vast area between microwaves and the optical window. Ground-based observations through the atmospheric windows in the infrared have been carried out. The first accurate measurements have been made of the positions and fluxes of the new class of infrared sources catalogued by the Air Force Cambridge Research Laboratory. Observations have been made in the very difficult submillimeter part of the spectrum with balloon-borne radio-meters. These have established the black body character of the background radiation far beyond the Planck maximum, and studies of the isotropy of the radiation put an upper limit of about 300 km/sec. for the motion of the earth with respect to the universe as a whole. In the course of these observations, an entirely new class of source which so far has been detected only at 5.5 mm wavelength was discovered. The flux of the source is one-tenth the flux of the Moon, and its nature is not understood so far. No such brilliant submillimeter source was expected on the basis of current knowledge. Work is also continuing on an infrared mixer that will allow coherent conversion of infrared in the 5 - 18 micron wavelength region to radio frequencies, thus bringing radio techniques to bear on problems that could only be studied by bolometers up until now.

Solid State, Laser, Plasma and Atomic Physics*

The Alcator (toroidal plasma device) experiment has come to fruition during the past year. This machine now operates reliably at fields exceeding 50 Kg, current densities in the 20-200 kamp range, and ion temperatures exceeding 1 keV. The device is also "cleaner" (for reasons not yet understood) than other Tokomaks, the Russian acronym for the machine. Alcator experiments have had considerable impact on the U.S. plasma confinement program. Two distinct (and controllable) modes of plasma behavior are observed in Alcator. At low densities (so-called "slide-away" regime) the plasma's dynamics are determined by collective effects. The relevant plasma modes have been identified, and their behavior has been correlated with that of the (non-Maxwellian) electron velocity distribution. At higher densities, the electron velocity distribution is Maxwellian, and the plasma is collision dominated ("classical" regime"). Here the confinement time and energy density increase with plasma density and plasma current. Record densities \(n = 2 \times 10^{14}/\text{cc}\) have been achieved with confinement times of 15 millisecond.

Atomic physics is being revolutionized by the development of tunable, dye lasers. The M.I.T. group is at the forefront in this work. Dye lasers produce relatively intense beams of excited atoms -- which are subsequently used in excited state scattering studies. Such experiments determine the force between the excited atom and target. Another experiment relies on the

* For a more extensive discussion, see the reports of the Center for Materials Science and Engineering, the Research Laboratory of Electronics, the Francis Bitter National Magnet Laboratory, and the Program in Health Sciences and Technology under whose aegis much of the research of members of the division is carried out.
Doppler shift and monochromaticity of the dye laser to produce excited atoms of prescribed velocity. Energy transfer, to target atoms, is then studied as a function of relative velocity. Dye lasers have also been used to excite atoms to high lying bound states such as the $n = 30$ level of Na, with radius 450 Å! The properties of these remarkable states are now under investigation.

Solid state bonding is enormously important, yet still not well understood. Present theories of chemical bonding rely on a semi-empirical correlation of experimental data. Recent work at M.I.T. has demonstrated that the magnetic susceptibility of solids can be used to determine specific features, such as spatial extent and symmetry, of valence charge densities in solids. These studies have led to a simple yet powerful chemical bond description of the susceptibility. This model is confirmed by a first principles, tight binding calculation. The theory is developed in a localized basis, hence can be applied equally well to crystalline or disordered solids. Ultimately, it is hoped that the methods developed in this work can be used to predict new materials, having unusual and interesting properties.

Neutron diffraction has been used to study the distribution of magnetization around dilute magnetic impurities in Cu (Kondo effect). The results conflict with several theories of this phenomenon, and may lead to major modifications in our understanding of dilute magnetism. Neutron scattering also has given fundamental new information concerning layer compounds (such as NbSe$_2$ and TaSe$_2$). These materials are important because they are the only ones known to exhibit well-defined, charge-density wave instabilities. The M.I.T. work (a classic study in this field) determines phase diagram, phonon dispersion curves, and a phenomenological model for two of these crystals.

The equation of state near a tricritical point was calculated using the renormalization group field-theoretic approach. Higher order critical points have been found where lines of tricritical points intersect; they are as different from tricritical points as tricritical points are from ordinary critical points. The mechanism of ionic selectivity has been studied intensively by means of the membrane-active ion-specific antibiotics. The first experimental evidence has been obtained that can discriminate between a steric theory and an electrostatic theory -- this evidence, from Raman spectroscopic measurements of the carbonyl stretch vibration frequencies -- favors the electrostatic theory. The conformational changes associated with muscle proteins have been probed with Raman spectroscopy.

A new theoretical method has been developed for the calculation of wave functions in non-periodic solids. Though computer oriented, this technique is far less time consuming than previous ones. The method is now being used to study the electronic properties of amorphous solids, surfaces, and vacancies.

Optical beating techniques have been used to determine the speed of blood flow in the human retina, and to characterize high molecular weight protein aggregates responsible for cataracts. Both results may be important in the control of eye disease. The biophysics group has also made a basic advance in the understanding of the role of protein polymerization in the allosteric control of enzyme-glutamate dehydrogenase.

In work performed at the Francis Bitter National Magnet Laboratory (N. M. L.) (see also the separate report from this laboratory) lasers are used to create and heat plasmas. These studies (both theoretical and experimental) are ultimately directed toward a CO$_2$-laser excited, magnetically confined plasma fusion device. N. M. L. also is developing intense, far infrared sources. The Energy Research and Development Association plasma-confinement program has an urgent need for such sources to measure the properties of thermonuclear plasmas.

Optical techniques are being used to determine the equation of state of FeBr$_2$ near its tricritical point. Iron halides are classic tricritical materials. These experiments, in
collaboration with N. M. L. will provide a searching test of theories of tricritical behavior.

The laser group has several, potentially important, programs in progress: 1) development of high speed, integrated, metal-oxide-metal junctions for infrared detection and generation; 2) laser studies of atomic and molecular collisions; 3) nonlinear spectroscopic studies of molecules; and 4) development of high power laser sources for nonlinear spectroscopy and excited state chemistry.

Raman scattering has been used for precision studies of roton-roton bound states in liquid He. The experiments confirm the existence of roton pairs, and determine their binding energy, lifetime, etc. A Fano-type model is used to explain roton-pair decay into phonons.

Balloon experiments are being used to study the anistropy of the $3^0K$ ("big bang") radiation which pervades the universe. To date, these measurements find no anisotropy greater than 0.1 percent. The experiment has been improved to probe anisotropies at the 0.01 percent level. If none are detected, a major revision of cosmological theories will be required.

Tunneling experiments into superconductors determine phonon state densities and other important parameters characterizing the superconducting state. Recent tunneling measurements in Nb give parameters which conflict with current theory, and suggest a re-examination of our present view of high transition temperature superconductors. This work is now being extended to A-15 materials, which are the basis for most present large-scale applications of superconductivity. A parallel effort in synthesis of novel A-15 compounds is under way.

A many-body theory of quasi-one-dimensional conductors has been developed. Calculations of conductivity and thermodynamic properties are in reasonable agreement with experiment. Calculations of the phase diagram of superfluid He$^3$ are in progress. Preliminary work indicates that the Fermi liquid parameters for the normal phase, can be used to give a description of the phase transition which agrees (within 10 percent) with experiment.

Development of the "molecular microscope" continues. A second generation, scanning desorption and scanning aperture microscope is now being tested. Studies of absorption on heterogeneous surfaces, including natural and synthetic biomaterials will begin soon. A foil electron lens has been shown to have negative spherical aberration. This device can be used to correct objectives of electron microscopes and related instruments.

Finally, an experimental program to study small (50 atoms or less) droplets of He$^3$ and He$^4$ has been started. These systems are of considerable interest to nuclear and many-body theorists.

Faculty

Professor Clifford G. Shull was elected to the National Academy of Sciences. The following faculty members received promotions during the year: Aron M. Bernstein, J. David Litster, and Richard K. Yamamoto from Associate Professor with tenure to full Professor; John W. Belcher, David E. Pritchard, and June L. Matthews from Assistant Professor to Associate Professor; and Roshan Aggarwal and Claude Williamson to Senior Research Scientist. Judith Bostock was promoted from Instructor to Assistant Professor, and Toyoichi Tanaka was promoted from the Office of Sponsored Programs staff to Assistant Professor. Stephen Steadman was appointed Assistant Professor, and Dr. Robert Birgeneau was appointed Professor with tenure, coming to M.I.T. from Bell Laboratories.
The principal research activities of the Spectroscopy Laboratory during the past year included the following: Professor Richard C. Lord and his associates, in collaboration with Professor Alexander Rich of the Department of Biology, succeeded in showing that the molecular structure of phenylalanine transfer RNA is the same in crystalline form and in aqueous solution. Thus the detailed structure as worked out by X-ray crystallography is valid for the aqueous medium of living cells, so far as the quite detailed information given by laser-Raman spectroscopy is able to discern. It was also found that removal of magnesium ions from the native tRNA molecule produces a partial disordering of its ribophosphate backbone and a lowering of its melting temperature. The melting was shown to be a complex process in which the adenine bases "melted" at a lower temperature than the backbone and the guanine bases at a slightly higher temperature. Professor Lord's group also continued their work in the mechanism of protein denaturation as seen in the Raman spectrum. Detailed studies of the
reversible thermal denaturation of the enzyme ribonuclease are in fair agreement with mechanisms proposed by others on the basis of chemical studies and absorption spectroscopy.

In the past year, Professors Ali Javan and Michael Feld of the Department of Physics, and their co-workers, have completed a study of collision broadening of water vapor using a tunable 5 μm spin-flip Raman laser. Work also has been done on sum-frequency mixing of two 5 μm beams in a nonlinear Proustite crystal in order to obtain a tunable source in the 2.5-μm region. A wave-guide CO2 laser is being developed as a tunable 10-μm source. The study of NO with a spin-flip Raman laser has also been initiated. It is hoped to extend this work to two-photon spectroscopy of NO by making use of some near coincidences between transitions in NO and CO laser lines.

More detailed studies of the velocity dependence of collision broadening cross-sections in NH3 have been carried out using counterpropagating waves of different frequencies to observe saturation resonances for molecules of specified velocity along the laser direction. Resonances have been observed for molecules having from two-thirds to more than four times the average thermal energy. Self-broadening of NH3 is found to increase only slightly with velocity, while broadening by xenon shows a much larger increase, in accordance with the different nature of the intermolecular forces responsible for the broadening in the two cases. This system also has been extended to the observation of population inversion by adiabatic rapid passage in an infrared transition of NH3. Inversion is achieved by rapidly sweeping a strong saturation field, and probed with a weak counterpropagating field as in a Lamb-dip experiment. Investigations of superradiance in optically pumped HF gas are being concluded and the results prepared for publication.

An infrared band contour analysis, carried out on the γ3 absorption of SF6 at 150° K by Associate Professor of Chemistry Jeffrey I. Steinfield and his student Dr. Paul Houston permitted indentification of the specific rotational levels involved in the pumping of SF6 by a CO2 laser. This pumping is the basis for laser-isotope separation methods currently under development. In the infrared double-resonance spectroscopy research area, a polarization effect was found by Dr. D. S. Frankel, an M.I.T. graduate, which indicated the persistence of molecular alignment during inelastic collisions. Infrared-microwave double resonance spectroscopy, carried out by Dr. Gregory Dobbs of the Department of Chemistry and graduate student, R. Micheels, yielded measurements of T1 and T2 relaxation times for NH3. T2 for SO2 rotational levels has also been measured by transient nutation spectroscopy, and additional double resonance experiments on OCS and SO2 are currently in progress.

Professor James L. Gole, of the Department of Chemistry, and his students have studied the chemiluminescence and laser-induced fluorescence of a number of high-temperature systems at pressures ranging from low "single-collision" values to the much higher multicollision range. Among the systems in the low-pressure range where the oxidation and halogenation products of scandium, yttrium, and lanthanum, by which lower bounds were set to the dissociation energies of the oxides and monofluorides of these elements. At the higher pressures, spectra of the hydrazine-fluorine flame have been measured and the free radicals NH, NHF and possibly HN2 have been identified as constituents of the flame. The observation of HN2 has not been reported previously and analysis of the data is continuing to evaluate the rotation and vibrational parameters of this molecule. Other systems studied include disilane-halogen and pentaborane-halogen interactions. When complete, these studies should reveal the kinetics of the highly exothermic flames; also it seems reasonably clear that both systems hold high promise for the development of new chemical lasers.

During the past year the two 5-m echelles and two 10-m Czerny-Turner spectrographs of the Laboratory have been realigned and put to use in the measurement of high-resolution molecular spectroscopy. Professor Robert W. Field and Dr. John Lombardi, of the
Department of Chemistry, have examined the spectrum of trifluoronitrosomethane in preparation for tunable laser excitation of its spectra. Work is in progress on re-analysis of the spectra of the diatomic species CN, SiO, SiS, BeO, BeS, and BaS and that for NO has been completed. All the necessary computer programs concerned with these analyses are now operational.

Postdoctoral fellows working in the Laboratory during the past year included Dr. Lombardi and Dr. Michael C. Chen.

RICHARD C. LORD

George R. Wallace, Jr. Astrophysical Observatory

The George R. Wallace, Jr. Astrophysical Observatory is an active teaching facility as well as a sophisticated scientific installation. It consists of one 16-inch and one 24-inch telescope housed in separate domes, a computer facility designed to control the 24-inch telescope and process data on-line, and a support building.

The observatory steering committee is appointed by the Dean of the School of Science and chaired by Professor Thomas B. McCord, of the Department of Earth and Planetary Sciences. Professor McCord also serves as the Director of the Observatory. Committee members are: Professors Alan H. Barrett, Bernard F. Burke, George W. Clark, Susan G. Kleinmann, and Institute Professor Emeritus Bruno B. Rossi, all of the Department of Physics; Professor R. A. Alberty, Dean of the School of Science; and Professor Irwin I. Shapiro, of the Department of Earth and Planetary Sciences.

Professor Herbert S. Bridge, of the Department of Physics and the M.I.T. Center for Space Research, advises and assists the committee. This body prescribes observatory policy and determines the direction of observatory development.

In January, 1975, Michael Brookes became the Chief Engineer of the Wallace Observatory, with Andrew Tomer continuing to function as site manager and technical assistant.

During fall, 1974, both telescopes were used regularly by students enrolled in subjects 12.111 Survey of Astronomy, 12.113 Astronomy I, and 12.143 Experimental Optical Astronomy. The total number of students enrolled in these subjects was 106. A total of 74 students enrolled in subsequent subjects 12.112 and 12.116 during the spring term frequently used the facility as well. The special student research for which the Wallace telescopes were used included such projects as testing the astrophotographic capabilities of the 24-inch; astrophotography with interference filters on the 16-inch; observations of A peculiar (AP) stars for absorption features; narrow-band photometry of Cygnus X1 centered on emission lines of Wn stars; and search of supernovae remnants for pulsing optical objects. Two major student instrumentation projects were: 1) the development of a computer program which could control the two-beam photometer, and 2) the design and development of a silicon vidicon imaging system to be used under computer control at the telescope.
The Wallace Observatory has been and will continue to be used for development and testing of new instruments which are later used at major observing facilities around the world. Tested are instruments such as the vidicon polarimeter, vidicon spectrometer, and various photometers.

From summer, 1974 through spring, 1975, the 16-inch telescope was scheduled for observing on 42 percent of total nights, and the 24-inch was scheduled for 62 percent of total nights. As expected, the telescopes were most heavily scheduled during academic year 1974-75 rather than in the summer. It should be noted that this year was the first full academic year during which the observatory could be scheduled on a regular basis.

During the spring, the observatory co-sponsored an international conference on optical telescope automation which was held at M.I.T. The Wallace facilities were demonstrated to 35 astronomers from several countries. During this conference and demonstration, representatives from major observatories throughout the world enthusiastically exchanged information on various automated systems.

THOMAS B. MCCORD
Graduate School

The past academic year was marked by growth of the Graduate School, as indicated by an increased number of students, expanded graduate programs, and the improved quality of graduate education. Concerted effort and attention was directed to women, minority, foreign, and special graduate students, with the result that considerable progress was made in all of these categories. Financial aid for graduate students continued to be the major problem, as Federal fellowship support declined and tuition and the cost of living escalated. To some small degree these adverse factors were counteracted this year by a small increase in industrial and foundation fellowships and by new Federal traineeship and college work-study programs.

The serious financial problems of many students, plus the scarcity of jobs for degree candidates, contributed to an intense and serious application by the graduate students to their degree programs. One result of this was an increased number of publications based on thesis research performed by graduate students in collaboration with their faculty supervisors. A related development was the fact that during the past year several graduate programs at M.I.T. were rated at the very top in terms of the quality of faculty and academic subjects. This high rating helped students considerably in applying for fellowships and in seeking jobs after graduation.

A systems approach to the solution of societal problems, which utilizes a data base and a theoretical approach related to many fields, is becoming increasingly important at M.I.T. One result of this development has been the creation of several new interdisciplinary programs. These are broad in scope and cut across departmental, and even school and institutional, boundaries. Such broad programs require special attention to prevent them from becoming shallow and superficial. The past year saw the development of a number of such interdisciplinary graduate degree programs which should enhance M.I.T.'s contribution to the needs of society, government, and industry.

Enrollment of Graduate Students

In the years from World War II until 1965, the enrollment of graduate students at M.I.T. increased rapidly, but since that time it has remained relatively stable. Factors such as the Vietnam War, Selective Service, economic depression, unemployment, and a major decrease in Federal fellowships have kept in check the rise of enrollment. New additional factors, such as a decline in the undergraduate college population and a major increase in cost of graduate education, will mitigate against the growth of private graduate schools in the future.

The above factors have already resulted in zero or even negative growth in many private graduate schools, but at M.I.T. the pattern has been somewhat more encouraging. In 1965, the enrollment of regular graduate students was 3,200, but by 1973, it had risen modestly to 3,358. In September, 1974, it underwent a further increase to 3,468. In a similar fashion, the number of special graduate students has increased from 339 in 1973, to 446 in
1974. A recent study completed by Dean Jeanne E. Richard forecasts a future increase of about 150 regular students for the academic year beginning in September, 1975.

As mentioned above, the major impediments to continued growth in the future will be the expected decrease in the number of college students in the U.S. who wish to pursue graduate degrees, the prohibitively high costs of private universities, and the scarcity of jobs available to students holding graduate degrees. To a very limited extent, the high costs have been met by fellowships and assistantships, but these are adequate to cover cost of tuition and living expenses for only half of the students. Special efforts will be required in the future to generate additional financial aid for graduate students.

**Fellowships, Scholarships, and Assistantships**

In the past, Federal fellowships and traineeships have provided major support for graduate students. Since 1968 there has been a significant decrease in such programs, and a number including the National Science Foundation (NSF) traineeships, National Institutes of Health (NIH) fellowships, and the National Defense Educational Assistance (NDEA) traineeships, have been phased out completely. Still in existence are NSF fellowships, primarily in science and engineering, and the NIH traineeships in the health sciences. Beginning in 1974, a new NSF trainee program was established in the field of energy. Already this very modest program has been curtailed for 1975. In the national competition for energy fellowships, M.I.T. ranked second in the nation for 1974 and first in 1975. Despite the new energy fellowships, the decrease in Federal funding is discouraging; for example, in 1968 there were about 800 Federal graduate student fellows, while in 1974, there were only about 400. This represents a loss of about $3 million per year in graduate student support. There is no basis for optimism about an increase in Federal support of graduate students in the foreseeable future. Information on graduate student support is summarized in Tables III and IV.

The impact on M.I.T. of the 50 percent decrease in Federal graduate fellowships has been a matter of grave concern to the administration and the faculty. To cushion the blow during a transition period, the administration made available on an emergency basis special graduate traineeships in the physical sciences and engineering derived from the Sloan Basic Research Fund. This fund, which supported 40 Sloan trainees in 1973 and 32 in 1974, will no longer be available for graduate students in September, 1975, since it must revert to its primary purpose of supporting faculty research. In retrospect, it is apparent that these Sloan traineeships played a crucial role in making it possible for the Graduate School to weather the crisis caused by the catastrophic decrease in Federal aid, and, as a result, the Graduate School at M.I.T. has survived better than most during these difficult years. In summary, over this period some 258 graduate students have been supported by Sloan traineeships at a cost of approximately $1.7 million. A special challenge for the future will be to generate new sources of funds to replace the lost Federal and Sloan monies. With this in mind, the Institute has indicated that an appreciable portion of the funds to be raised in the Leadership Campaign launched in April, 1975, will be allocated to student financial aid.

The economic depression, accompanied by the stock market decline in 1974, has been responsible in part for the 60 percent decrease in industrial, foundation, and private graduate fellowships which has occurred in recent years. In an attempt to replace this loss, departments, in cooperation with the Resource Development Office, have been urged to raise new fellowships by direct contact with industry and foundations. This effort has met with only modest success but will be intensified during the Campaign. In addition, the Graduate School, with the help of the administration, has been successful in raising money from industry, foundations, and private individuals to support 22 new fellowships. This
represents an income of about $175,000 per year and, while modest in relation to the
desperate need, demonstrates what might be achieved in the future.

By far the most important form of support for graduate students is assistantships which
also contribute to the students' education and training in research. Similarly, these
assistants participate significantly in the teaching and research activities of the Institute.
Nearly one-half of the graduate students work as part-time assistants; during the past year
there were 1,142 research assistants and 467 teaching assistants. Although the large volume
of research contracts (expected to increase modestly next year) has maintained the number
of research assistantships at a constant level, the number of teaching assistantships has
dropped somewhat because of severe budgetary constraints on academic programs -- con-
straints expected to continue in the future. Although assistantships traditionally cover
tuition and living costs, it has been necessary in some cases to cut assistantships from half
to quarter time, with a corresponding decrease in their stipends. While the number of
teaching assistants at M.I.T. does not compare with state universities, the number of
research assistantships is considerably higher because they are funded from the large
number of research grants supervised by M.I.T. faculty. New areas of research (e.g.,
energy and cancer) are now providing exciting opportunities for support of graduate
students' dissertation research.

Graduate students who live in undergraduate dormitories and serve as resident tutors are
providing teaching opportunities of an informal nature. This tutorial system, supervised
by the Dean for Student Affairs, provides room, board, and counseling experience for
about 50 graduate students. Undergraduates view the program as a valuable adjunct to their
formal education in the classroom, and graduate students feel it is excellent training for
them.

A small Energy Training Grant from NSF is now available for graduate students whose
theses relate to coal or environmental research. Closely related to this is a similar
program in mining (including petroleum) sponsored by the U.S. Office of Education.
Under this program for 1975-76, M.I.T. received nine three-year traineeships, while
the second new program has provided two such traineeships.

The one encouraging spot in the financial aid picture is the new Federal College Work-Study
Program (CWSP) which became available for graduate students at M.I.T. in fall, 1973.
In this program, financially needy students can be employed for up to 40 hours per week,
primarily in teaching and research laboratories (other kinds of jobs are also available) with
80 percent of their stipends paid from Federal funds and 20 percent paid by the employer.
This program, administered jointly by the Student Financial Aid Office and the Graduate
School Office, was funded with $245,000 during 1974-75, but in September, 1975, $320,000
of government money will be available for this purpose. While in the past some consideration
was given to the need of students from departments which lacked extensive financial resources
for graduate student support, in 1975-76 CWSP funds will be available to all students who
demonstrate need, regardless of their department or research laboratory affiliation. Since
need is generously defined (total resources of less than $6,400 for nine months), many students
will be eligible for at least a modest amount under the CWSP program, and hence, a large
number of students who wish part-time employment while pursuing degrees can receive
assistance. In times of budgetary constraints, faculty and research directors will be able
to hire skilled graduate students to assist them and only have to pay 20 percent of their wages
from their own research funds.

Practically all students who have serious financial problems are eligible for bank loans
arranged through the Student Financial Aid Office. Such loans amounted to over $1 million
during 1974-75 (see Table V). These loans are designed primarily to take care of financial
emergencies and should not be regarded as constituting the sole support of graduate education.
Despite the fact that great efforts are being devoted to the problem of financial aid for graduate students and although considerable progress has been made, the situation remains grave and no real solution is apparent. Decreases in scholarship, fellowship, and assistantship support will continue to limit the rate of growth of the Graduate School at M.I.T. Despite this limitation, the School is in robust physical and intellectual health and will doubtless increase in size and quality in the years to come.

Minority Graduate Students

Seven years ago, it became apparent that the number of minority students in the Graduate School, 16, was disappointingly small and that no significant increase would occur unless a plan was developed and executed for "Affirmative Action." Such a plan was effected to recruit, as well as provide special tutorials, counseling, and financial assistance for minority students. As a result of this program, the number of minority graduate students has rapidly increased and reached 151 in 1974. We expect that this number will increase further in fall, 1975, but this growth cannot continue indefinitely unless new funds can be found to support more minority students. The recruitment of minorities has included blacks, Mexican-Americans, Puerto Ricans, and American Indians. In the coming year, a few Asian-Americans will be included on a very selective basis in the graduate program. This will apply only to a few departments where disadvantaged Asian-Americans are seriously underrepresented at this time.

During 1974-75, the Minority Graduate Program was ably supervised by Dean John B. Turner. Working with him was a special advisory committee consisting of faculty, administrators, and students. In addition, each academic department had its own minority student advisor who coordinated his or her work with Dean Turner's office.

Since its inception, the recruitment effort has encountered difficulty in attracting engineering students, since the pool enrolled in undergraduate colleges is disappointingly small. Beginning in summer, 1975, several black undergraduate students will be given summer jobs and tutorial assistance from Lincoln Laboratory. The most outstanding of these students who apply for and are admitted to graduate school in engineering at M.I.T. will be supported by the Laboratory. A somewhat similar program involving a national consortium of universities and industrial laboratories (including the Charles Stark Draper Laboratory) is in the planning stage and should be implemented in 1976. Both of these proposed programs should lead to an increase in the pool of minority students available for graduate work in the School of Engineering. In addition, these cooperative efforts will furnish financial aid for these students.

Special attention has been devoted to the recruitment of M.I.T. undergraduate minority students for graduate school here. The prestigious Fort Fellowship sponsored by the Graduate School Office has been particularly effective in attracting minority seniors into graduate degree programs at the Institute.

Women Graduate Students

As a result of intensive efforts to encourage women to enter the fields of science and engineering during recent years, the number of graduate women at M.I.T. has risen from 302 (9 percent) in 1967 to 405 (12 percent) in 1974, with a further increase (14 percent) predicted for September, 1975. This increase also reflects a developing interest of women in graduate study. At M.I.T.
the environment for women has been made more attractive as a result of improved graduate housing, athletic facilities, extracurricular activities, and counseling services. Financial aid is especially important for the recruitment of women, and special fellowships have been set up for this purpose. These include the IBM, Collamore-Rogers, and the Ida Green fellowships. The latter provides six fellowships for entering graduate students and is made possible by a generous endowment of $1 million given by Cecil and Ida Green. All of these efforts should result in a further increase in the number of women and will help to make M.I.T. a more enjoyable place for them to carry on their graduate studies.

Foreign Graduate Students

Because of M.I.T.'s international reputation, it is perhaps not surprising that a large number of foreign students come here for graduate study. During 1974-75, 28 percent of the graduate students came from outside the United States, a figure considerably higher than that of all comparable institutions in this country. Foreign students face special financial problems since it is difficult for many of them to raise the $9,000 needed for tuition and living expenses each calendar year. Federal and many other fellowships are not available to foreign students, and in addition, the State Department has placed severe restrictions on summer employment possibilities for foreign students.

More than half of these students receive support from M.I.T. in the form of assistantships and scholarships. Still others obtain help from their governments or families. In spite of these several forms of financial aid, a large number of foreign students have financial problems which are not easily solved. Even when these students return to their native lands, their difficulties often continue because of the scarcity of jobs for professionally trained graduates.

A new facet in the education of foreign graduate students at M.I.T. developed with the admission in June, 1975, of 27 students from Iran who are candidates for the Master of Science degree in Nuclear Engineering. Another 27 are expected to arrive next year, so that by September, 1976, there should be 54 Iranian graduate students in that department. These students, selected by their government and by M.I.T. will receive Iranian fellowships which will pay their full costs for two years at the Institute. A special faculty committee appointed by the President of M.I.T. will study this program and its implications for the future, and the Committee on Graduate School Policy (C.G.S.P.) will be responsible for monitoring the academic progress of the students from Iran.

New Graduate Degree Programs

The development by the faculty of new areas of research has inevitably resulted in the movement of graduate students as well into these new fields. In general, these new areas of research cut across disciplinary boundaries and require collaboration among faculty in several departments at M.I.T. In some cases cooperative programs involve other institutions as well. The past year was one of keen activity in the design of new curricula for degree programs, and after intensive study and review by the C.G.S.P., the Academic Council, and the faculty, three such programs were approved by the Corporation to begin in fall, 1975.

The Department of Architecture was the only graduate department which did not have a program leading to a doctoral degree. This situation has now changed with the approval of
a Ph.D. program in Architecture, Art, and Environmental Studies. The initial focus will be in the areas of history, theory, and criticism of architecture and art, but will soon be extended to include design methods in architecture, art, environmental design, and building technology.

The School of Science will administer a new master's degree program in Interdisciplinary Science to be guided by a group of faculty who now supervise the undergraduate curriculum in Course XXV (General Science). This faculty committee will admit students, advise them concerning their programs of study and theses, and finally, recommend them for S.M. degrees in Interdisciplinary Science. Curricula emphasize applied science and cut across departmental boundaries. Students registered for this degree may pursue an unstructured curriculum tailored to fit their needs, or a less flexible, but carefully designed curriculum. In the latter case, special programs are now available in science education and in animal cell culture. Other areas will be added to this list in the future. The S.M. degree in Interdisciplinary Science has been approved as a three year experiment and will be monitored by C.G.S.P. which will report to the Faculty regarding the program's progress.

The third program to receive approval (also a three year experiment) is one leading to the S.M. degree in Technology and Policy. This program will be sponsored by the School of Engineering and will be guided by an interdepartmental steering committee appointed by the Dean of the Graduate School and the Dean of the School of Engineering. Students applying for this degree will be screened and supervised by this committee, but will be registered in the various departments of the School of Engineering. Students completing this program might be employed in government or industry doing needs analysis, impact studies, technology assessment, and project evaluation, as well as planning policies and facilities design for large scale systems. In addition to professional subjects in engineering and technology, the program will require a broad based social science component. The problem-oriented thesis will include policy and social considerations as well as technology.

**Graduate Student Affairs**

The Graduate School Office cooperates closely with the Graduate Student Council (G.S.C.) in many different ways. In academic matters, the G.S.C. is represented on the C.G.S.P. by two students who participate on a regular basis in its monthly meetings. During the spring term, under the chairmanship of the Dean of the Graduate School, an ad hoc committee of administrators and graduate students made a detailed study of problems relating to graduate student housing. Special attention was paid to the problem of escalating rents in student housing related to rising fuel and other costs.

The most important cooperative project of the G.S.C. and the Graduate School Office was the orientation day held in September, 1974, for new graduate students. Major credit for the success of this affair is due to the leadership of John Foss, G. who was ably supported from the Graduate School Office by Dean Richard. For the smaller number of graduate students who entered in February, 1975, the G.S.C. held a successful mini-orientation in the Muddy Charles Pub. Another new endeavor of the G.S.C. is the publication of an excellent newspaper called The Graduate.

With the completion of the Tang Tower, built to house 400 single graduate students in apartment-style living, and with the total renovation of Ashdown House completed in summer, 1974, the housing facilities for married and single graduate students have been greatly improved. As a result, it is now possible to house about one-half of the graduate student body on campus. A study is now under way, led by Vice President and Dean Kenneth...
Graduate School

Wadleigh, to determine the future needs for on-campus housing for graduate students.

Academic Concerns

Special effort has been made during the past year to place greater emphasis upon broadening graduate education, while making certain that it does not become superficial. More than ever before, graduate students are electing subjects which are not directly related to their major. Indeed, many of these students are choosing interdisciplinary programs and theses which cut across boundaries between various fields of interest. Despite these trends, graduate education remains highly organized within the 23 departments which offer graduate programs, and the prestige of M.I.T.'s graduate school is dependent on the collective reputations of each individual department.

Graduate schools are continually searching for indices which relate to the quality of their programs, and M.I.T. is no exception. During the past year, our Schools of Engineering and Architecture and Planning were rated first and the Sloan School of Management sixth in the United States by deans of professional schools in this country. M.I.T. is also at the very top with reference to the number of Hertz Fellows and NSF Fellows who come for graduate study. The Institute also has the largest number of graduate student research assistants in the country.

In 1974-75, the quota system for the number of graduate students in each department was abandoned. Each department was permitted to admit students as it saw fit, keeping in mind the quality of applicants, financial aid available, and facilities to accommodate these graduate students. The School Deans and the Dean of the Graduate School were given the responsibility for monitoring the admissions procedure so that proper balance would be maintained. The first year's experience with this "non-quota system" was remarkably successful. The net result was an overall increase of about 100 graduate students, a figure well within M.I.T.'s ability to accommodate a larger number of students at the present time.

Staff Changes

Dr. John B. Turner joined the Graduate School in September, 1974, as Assistant Dean for Minorities.

Ronald S. Stone resigned his position as Executive Officer and Assistant Dean in November, 1974, to become Associate Director of the Alumni Fund.

Professor Sanborn C. Brown retired as Associate Dean of the Graduate School in June, 1975, to become Professor of Physics, Emeritus.

Professor Irwin W. Sizer retired as Dean of the Graduate School in June, 1975, to become Dean of the Graduate School, Emeritus; Consultant in Resource Development; and President of the Health Sciences Fund, Inc.

Professor Kenneth R. Wadleigh, while continuing as Vice President, took on the additional responsibility of Dean of the Graduate School in July, 1975.
Epilogue

After serving for 40 years on the M. I. T. faculty, the last eight as Dean of the Graduate School, I wish to take this opportunity to express my gratitude to M. I. T. for making my career so exciting and satisfying. I also wish to say to my colleagues in the Department of Biology, in the Administration, and in the Graduate School how much I have appreciated the friendships which have developed over these many years and how sincerely I have enjoyed the cooperation and support which I have always received. To my dear friend and colleague, Professor Wadleigh, I wish great success and joy in his new role as Dean of the Graduate School.

IRWIN W. SIZER

<table>
<thead>
<tr>
<th>Advanced Degrees Conferred</th>
<th>M. Arch. M. C. P.</th>
<th>S. M.</th>
<th>Engineer</th>
<th>Sc. D.</th>
<th>Ph. D.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>September, 1974</td>
<td>16</td>
<td>168</td>
<td>28</td>
<td>14</td>
<td>102</td>
<td>328</td>
</tr>
<tr>
<td>February, 1975</td>
<td>19</td>
<td>191</td>
<td>21 (WH)*</td>
<td>20</td>
<td>95</td>
<td>349</td>
</tr>
<tr>
<td>June, 1975</td>
<td>54</td>
<td>408</td>
<td>56</td>
<td>16</td>
<td>108</td>
<td>648</td>
</tr>
<tr>
<td>TOTAL</td>
<td>89</td>
<td>767</td>
<td>107</td>
<td>50</td>
<td>312</td>
<td>1,325</td>
</tr>
</tbody>
</table>

*Woods Hole Oceanographic Institution
### Table II Graduate Student Enrollment
**Fall Term, 1974 -- Regular Graduate Students**

<table>
<thead>
<tr>
<th>School of Architecture and Planning</th>
<th>Foreign*</th>
<th>Women</th>
<th>Minority**</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>School of Engineering</td>
<td>525</td>
<td>64</td>
<td>38</td>
<td>1,620</td>
</tr>
<tr>
<td>School of Humanities and Social Science</td>
<td>65</td>
<td>55</td>
<td>34</td>
<td>282</td>
</tr>
<tr>
<td>Sloan School of Management</td>
<td>101</td>
<td>49</td>
<td>10</td>
<td>348</td>
</tr>
<tr>
<td>School of Science</td>
<td>219</td>
<td>158</td>
<td>28</td>
<td>970</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>970</td>
<td>405</td>
<td>151</td>
<td>3,468</td>
</tr>
</tbody>
</table>

* Includes Canadians  
** Includes black Americans, Puerto Ricans, Mexican-Americans, and American Indians

### Table III Summary of Graduate Financial Assistance for 1974-75

<table>
<thead>
<tr>
<th>Source</th>
<th>Amount</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Regular Graduate Students</td>
<td>3,468</td>
<td></td>
</tr>
<tr>
<td>Federal Fellowships and Traineeships</td>
<td>373</td>
<td>11%</td>
</tr>
<tr>
<td>Graduate Student Staff</td>
<td>1,609</td>
<td>46%</td>
</tr>
<tr>
<td>Industrial and Foundation Awards</td>
<td>166</td>
<td>5%</td>
</tr>
<tr>
<td>M.I.T. Endowed and Budgeted Funds</td>
<td>242</td>
<td>7%</td>
</tr>
<tr>
<td>Students Sponsored by External Sources</td>
<td>513</td>
<td>15%</td>
</tr>
<tr>
<td><strong>TOTAL AWARDS</strong></td>
<td>2,903</td>
<td>84%</td>
</tr>
</tbody>
</table>
## Table IV Graduate Student Support

The sources of support for most of the M.I.T. graduate students in 1974-75 are listed. However, a single table is an incomplete reflection of the total picture since support shifts constantly throughout the academic year in accordance with changing status, early termination of degree program, and so on. Because of the statistical problem created by this constant change, this table was devised to present a representative "snapshot" in effect. For purposes of this count, a full award was considered as at least full tuition support during the fall term, 1974.

### Fellowships and Traineeships Awarded by M.I.T.

<table>
<thead>
<tr>
<th>Source of Support</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Institutes of Health and other Health Education, and Welfare (HEW) Traineeships</td>
<td>164</td>
</tr>
<tr>
<td>M.I.T. Endowed and other Fund Fellowships</td>
<td>210</td>
</tr>
<tr>
<td>Industrial and Foundation Fellowships</td>
<td>130</td>
</tr>
<tr>
<td>Sloan Research Traineeships</td>
<td>32</td>
</tr>
<tr>
<td>National Science Foundation Energy Traineeships</td>
<td>12</td>
</tr>
<tr>
<td>Atomic Energy Commission Traineeships</td>
<td>6</td>
</tr>
<tr>
<td>Environmental Protection Agency Traineeships</td>
<td>6</td>
</tr>
<tr>
<td>National Defense Education Act Traineeships</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>563</strong></td>
</tr>
</tbody>
</table>

### Fellowships Awarded by Sponsors to M.I.T. Students

<table>
<thead>
<tr>
<th>Sponsor</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Science Foundation Fellowships</td>
<td>176</td>
</tr>
<tr>
<td>Hertz Foundation Fellowships</td>
<td>18</td>
</tr>
<tr>
<td>Ford Foundation Minority Fellowships</td>
<td>13</td>
</tr>
<tr>
<td>General Motors Corporation Fellowships</td>
<td>5</td>
</tr>
<tr>
<td>Environmental Protection Agency Fellowships</td>
<td>3</td>
</tr>
<tr>
<td>National Institutes of Health and other HEW Fellowships</td>
<td>2</td>
</tr>
<tr>
<td>Department of Labor Fellowships</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>218</strong></td>
</tr>
</tbody>
</table>

### Student Assistantships

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>1,142</td>
</tr>
<tr>
<td>Training</td>
<td>467</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1,609</strong></td>
</tr>
</tbody>
</table>
Graduate School

Table V Graduate Loans, FY 1975

<table>
<thead>
<tr>
<th>Source</th>
<th>Number of Loans</th>
<th>Total Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M. I. T. Administered</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NDSL</td>
<td>57</td>
<td>$76,160</td>
</tr>
<tr>
<td>Technology Loan Fund</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guaranteed</td>
<td>223</td>
<td>$410,610</td>
</tr>
<tr>
<td>Non-Guaranteed</td>
<td>165</td>
<td>$285,875</td>
</tr>
<tr>
<td>Foreign/Subsidized</td>
<td>159</td>
<td>283,184</td>
</tr>
<tr>
<td><strong>Total M. I. T. Administered</strong></td>
<td>604</td>
<td>$1,055,829</td>
</tr>
<tr>
<td>Bank-Guaranteed Loans</td>
<td>104</td>
<td>217,424</td>
</tr>
<tr>
<td><strong>Total Long-Term Loans</strong></td>
<td>708</td>
<td>$1,273,253</td>
</tr>
<tr>
<td>Short-Term Loans</td>
<td>213</td>
<td>97,512</td>
</tr>
<tr>
<td><strong>TOTAL BORROWED</strong></td>
<td>921</td>
<td>$1,370,765</td>
</tr>
</tbody>
</table>

(1) Numbers of students borrowing in each of the total categories are fewer than the numbers of loan transactions recorded, since many students borrow from more than one source.
The annual reports that appear in this section are submitted by the heads of administrative departments and operations which report directly to the Office of the President and the Chancellor. The Council for the Arts at M.I.T. reports to the President through Professor Roy Lamson, Special Assistant to the President for the Arts. The Director of Information Processing Services reports directly to the Chancellor. The Institute Information Services and the M.I.T. Press report to Constantine B. Simonides, Vice President in the Office of the President and Chancellor.

Council for the Arts

The year 1974-75, the Council's second full working year, was one of considerable growth and development in the arts at M.I.T. A staff of five -- Professor Roy Lamson, Special Assistant to the President for the Arts; Peter Spackman, Executive Director; Susan Knight, Associate Director; Annette Anderson, Assistant Director; and Meredyth Patterson, Secretary -- worked with the members of the Council to further support and expand the growing range of artistic activities at the Institute.

Under the chairmanship of Max Wasserman, the Financial Development Committee met informally several times during the year in pursuit of the Committee's basic plan of soliciting ten $25,000-a-year units for the Council's first five years. By June 30, 1975, six such units were pledged and four group gifts were in progress in Boston, New York, Washington, D.C., and Chicago.

The Museum and Acquisitions Committee, chaired by Ida Rubin, has worked closely with M.I.T.'s Committee on the Visual Arts to obtain artwork for four new buildings on campus: the Fairchild Building (electrical engineering); the Cancer Research Center; the chemical engineering building (designed by Council member I.M. Pei); and the new West Campus student dormitory. In addition, the Committee has assisted with the acquisition of some 60 paintings, drawings, and sculptures for the permanent collection, as well as 94 works for the Institute's loan collection.

The Program and Information Committee, chaired by Leo Beranek, met regularly during the year and made 14 grants to a wide variety of programs in the arts at M.I.T. Groups receiving support included the Office of Exhibitions for filming "Visual Dharma," an exhibit of the Buddhist art of Tibet; the Visiting Writers Series for bringing well known writers and poets to discuss their work; the Student Art Association and the M.I.T. Dance Workshop for part-time instructors; MITV for the purchase of a synch generator; a group of students to purchase supplies for an Independent Activities Period (I.A.P.) metal casting course; and a group of students, faculty, and staff for a series of I.A.P. workshops exploring the uses of video in conjunction with other art forms. Two of the total number of grants were unused; the remaining 12 were allocated a total of $49,725.
Five new members were appointed to the Council by President Jerome B. Wiesner for three-year terms: John H. MacFadyen of New York City; Cornelius Van S. Roosevelt, '38, of Washington, D.C.; Mitchell Silverstein, '48, of Chicago; Sherwood B. Stockwell, '49, of San Francisco; and Alfred C. Wu, '40, of New York City. Total Council membership at the end of the year was 71.

In addition to work done through the standing committees, the Council continued publication of the Newsletter, which had two regular issues during the year with a circulation of approximately 8,000. At the suggestion of the Program and Information Committee, a calendar of arts events at M.I.T. was published each month beginning in October, 1974, and will be continued for the ten months of each school year. Circulation of the calendar numbers roughly 1,500 and is directed primarily toward various community organizations and the press.

The Council further initiated a proposal-writing service for arts programs and facilities at M.I.T. Proposals were researched, drafted, and processed through Institute channels before being sent to Federal agencies and private foundations. During the year, Hayden Gallery, the Department of Architecture, and the Visible Language Workshop, among others, used this service.

A particular highlight of the Council's year was the third Annual Meeting. The two-day meeting opened on November 6, with luncheon meetings for each of the Council's standing committees, followed by an afternoon of visits to the Institute's art centers and laboratories. At the annual dinner at the President's House, Council member Vernon R. Alden, who is also chairman of the Massachusetts State Council on the Arts and Humanities, spoke on the changing role of institutions -- corporations, universities, arts councils -- in the life of the arts. After dinner, the Council sponsored "An Evening with the Arts at M.I.T." This celebration at Walker Memorial was attended by 300 people from M.I.T. and other arts organizations in the Boston area.

The annual business meeting on November 7 included the presentation of the first annual Eugene McDermott Award given "for major contributions to the arts as a means of human fulfillment" to Professor Gyorgy Kepes, painter, author, and founder of M.I.T.'s Center for Advanced Visual Studies. The Award was established to honor the memory of the late Eugene McDermott, a Life Member of the M.I.T. Corporation and a benefactor to the Institute in education and the arts. During the afternoon, luncheon seminars were held by faculty members in music, drama, photography, visual arts, poetry, architecture, art history, and filmmaking. Following the seminars the Annual Meeting closed with remarks by President Wiesner who charged the Council with an ambitious and important task: to lead the way to a more satisfying industrial society in which environmental, aesthetic, and other human considerations share significantly with those traditionally overriding considerations of efficiency and economics in the development and exploitation of new technology.

In summary, it was a full year for the Council staff and members as well as for the many students and faculty engaged in the arts, a year in which we came a little bit closer to the ultimate goal of both enhancing the M.I.T. community as a whole and helping to provide students with experience in the arts that will complement the depth and insight of their experience in science and engineering.

PETER SPACKMAN
Information Processing Services

During the year, the planning for and management of the Institute's computing activities continued through the Information Processing Services Office and its three constituent departments: the Information Processing Center (I. P. C.), with primary responsibility for meeting the computing needs of the Institute's instructional and research programs; the Programming Development Office (P. D. O.), with the primary responsibility for systems planning and for operating systems development and maintenance; and the Office of Administrative Information Systems (O. A. I. S.), with primary responsibility for meeting the current and future information processing needs of the Institute's administrative programs.

Operations

Information Processing Center

The I. P. C. continued to provide slightly more than half of the computing services utilized by the instructional and research components of the Institute. In September, 1974, the System/370, Model 165 computer on which the Job Processing System operates was replaced with a System/370, Model 168, with increased processor speed, faster memory, and the hardware foundation for virtual storage. During the year, use of this system expanded with the number of revenue jobs from the M. I. T. community increasing by 4 percent. The average charge to the community for a batch processing job rose from $6.30 to $7.52. This growth in average job cost reflects both a price increase on July 1, 1974, and an increase in the amount of computer resource consumed by the average job. The number of time-sharing terminal hours supported on this system grew by 14 percent to a monthly average of 3,717. As an economy move, dispatching service was eliminated during the third shift beginning in January, 1975. The mean time between failures on the Model 168 averaged 21.9 hours during the last quarter of the year, essentially unchanged from the year before.

Use of the Multics service, operated on the Honeywell 6180 system, declined during the year with the average number of revenue terminal hours per month falling from 8,067 in fiscal year 1974, to 6,833 in FY75, a decrease of 15 percent. This decrease is due partly to the unacceptably high unit cost of this service and partly to a substantial decrease in demand by two of the largest users of the system. The problem posed by the lack of full utilization of the Multics service was addressed by the I. P. C. during the year, and a plan was developed to increase use substantially. Effective July 1, the online charges to users will be reduced by approximately 50 percent with the goal of doubling usage during the coming year. Multics will continue to be the main, general-purpose time-sharing system for the Institute for the indefinite future. The mean time between failures of the Multics service increased by 100 percent and stood at 34.7 hours during the last quarter of the year. In January, the hardware supporting the Multics service was modified with the installation of cache memory in each processor.

During the year, the I. P. C. made numerous changes, additions, and enhancements to the extensive library of applications software it maintains for the community. The publications and documentation services were expanded, and numerous noncredit subjects were taught.
Office of the President and Chancellor

Office of Administrative Information Systems

In October, 1974, the O.A.I.S. installed a System/370, Model 145 computer to replace the installed Model 135 computer which had become fully utilized. As a result of both the increased capability of the new hardware, and the continuous improvements in the effectiveness of the O.A.I.S. operations section, the percentage of the Office's output produced accurately and on time rose continually during the year. In the last quarter of the year, this index stood at more than 95 percent, compared to the Office's goal of 90 percent. Beginning July 1, 1975, the O.A.I.S. will increase its expected production goal to 95 percent. During the year, total usage of the O.A.I.S. facility climbed approximately 16 percent, following a 40 percent increase the year before. Though production use by the Institute's administrative offices did not change substantially, use of the facility for development grew.

Although the new hardware was a major factor in the improved service levels, a number of other efforts made the operations area more effective, including conversion to a standard job ticket, completion of a tape library control system, publication of operations documentation, reorganization of the control function to insure quality control of input, a ten percent increase in the percentage of jobs prescheduled, installation of new operating systems without serious disruption, elimination of two old programming languages, implementation of a formalized system development test procedure, and, most importantly, establishment of a participatory management system for supervisors giving them a stronger sense of responsibility and accomplishment.

Meetings between operations management and client offices increased substantially during the year with the result that communications on data transfer, operations methods, and problem reporting improved substantially. The O.A.I.S. operations section is participating in periodic meetings with a group of eight firms in the Boston area which have similar computer configurations and problems with the goal of improving the quality of the operations function, particularly in documentation and user interface. It is especially encouraging to note that many of the methods developed by the O.A.I.S. over the past three years are considered by this group to be unique and effective solutions to several major industry problems.

The O.A.I.S. systems development section completed its staffing requirements during the year, established a coherent, participative methodology for major development, and implemented a project control system for all systems development efforts. During the year, a new student account reporting system, a new student data base system complete with online processing to support the Office of the Registrar, and a modified computer billing system were installed. Each of these major new administrative systems represents substantial steps since they replaced old, poorly documented systems written in obsolete computer languages and with many dependencies on specific employees. The new systems are fully documented on both the systems and operational levels, are written in modern computer languages, and do not have dependencies on specific individuals.

During the year, the development section also began the design of a payroll and personnel system, a general accounts receivable system, and a system to support the Office of Laboratory Supplies. The number of system maintenance problems encountered this year declined substantially because during the last two years, identified problems have been solved for the long run rather than only for the short run. As a result, the size of the maintenance group has been reduced and further reductions are anticipated. The number of system modifications performed grew and averaged 29 per month. Due to increased staffing during the last three months of the year, the average time for completion of a modification began to shrink substantially. Toward the year's end, a new client service was developed which allows use of a report generator to query any existing file to produce outputs such as reports, listings, or labels.
Programming Development Office

During the year, the P.D.O. continued to maintain the computer operating systems and language processors utilized by the I.P.C. and the O.A.I.S. Maintenance of the OS/360 system on the System/370, Model 168 in the I.P.C. continued at a low level. High reliability was maintained with few changes being made. Maintenance of the Multics service included a level of system changes similar to the previous year, and a completion of improved input/output modules, new text preparation commands, and enhanced administrative tools. Three new versions of the D.O.S. operating system were installed for the O.A.I.S., one of which represented a major step with the implementation of virtual memory and online terminals. A major activity for the P.D.O. was the development for the I.P.C. System/370, Model 168 of the newest IBM operating system, OS/VS II Release 3 (MVS), scheduled for installation during 1975-76.

The P.D.O. also maintained the Relational Data Management System (a data base system of growing utility in the Institute's administrative programs) by making several improvements, including a report language and a complete manual. The Office serves as a consultant to several departments and research groups considering the acquisition of computer systems. During the year, the P.D.O. increased substantially its activity and capabilities in the areas of networking and computer communications. The coming year will see the Office become more heavily involved in the Institute's major administrative systems development program and in data base activities.

New Areas of Activity

Networking

During the year, the Institute continued to expand its activities in the computing network area through cooperating with the New England Regional Computing Program (NERComP), an organization of 30 institutions of higher education in New England, and the Planning Council on Computers in Education and Research of EDUCOM. Both organizations plan to implement interinstitutional networks, and M.I.T. is playing a leading role in each activity. In addition, during the year, the use of M.I.T. computer facilities by outside organizations grew substantially, particularly among other colleges and universities in the greater Boston area. Currently, more than one-third of the revenue of the I.P.C. comes from outside M.I.T. This is a major commitment for the Institute and presents both opportunities and problems. The Institute expects to be heavily involved in future networking organizations because this will facilitate the sharing of our own resources with others and will allow the acquisition of unique resources at a cost far lower than if we were to attempt to duplicate those resources on our own systems.

Minicomputers

M.I.T. has been an early and intense user of minicomputers in its programs of research. However, during recent years, the use of minicomputers in instruction has grown, and the possible use of such systems in administration can be easily anticipated. The P.D.O. is increasing its activity in the entire minicomputer area with the goals of developing an understanding of the total Institute need for different types of minicomputer service and of the capabilities available; establishing appropriate vehicles for communication between the minicomputer users on the administrative and technical level; and developing or facilitating appropriate hardware interconnection.

ROBERT H. SCOTT
Institute Information Services (I.I.S.)

Over the past four years, the concept of the Institute Information Services has been useful in the improvement of the channels of communication among information-related offices. For the past two years, representatives of I.I.S. and other staff members across the Institute, whose responsibilities involve receiving and disseminating information, have met together in the Information Group to brief each other on current developments and to discuss common interests and tasks. This informal but continuous encouragement of more open and cooperative sharing of information across departmental lines will be especially helpful in the months ahead as the Institute moves toward making administrative services more economical and cost-effective.

The activities of the I.I.S. departments during the past year are reported below by Robert M. Byers, Director of the News Office and Kathryn W. Lombardi, Manager of Campus Information Services.

CONSTANTINE B. SIMONIDES

News Office

The year 1974-75 was the busiest ever for the M.I.T. News Office. At the national level, hardly a week went by that the Institute or its people were not in the national news somewhere. Stories generated by the News Office about the substance of research at M.I.T. enjoyed remarkable popularity among newspapers and the wire services that provide them with news. The addition of a full-time photojournalist resulted in M.I.T.'s frequent representation among caption-only news and feature pictures sent by wire services to newspaper clients worldwide. Many of those pictures, it turned out, were of events occurring in the lobby of M.I.T.'s Building 7, and for the year that must have been the most publicized college lobby in America. Moreover, major news stories generated elsewhere and involving M.I.T. kept the News Office busy servicing inquiries from news media.

At home, the maturing of the Tech Talk newspaper as a medium for keeping the 15,000 people who live and work at M.I.T. not only informed about but interested in what is happening at the Institute was a mixed blessing. Never before have so many people used the columns of the newspaper. Where we once worried there would not be enough news to fill a newspaper, we found ourselves this year with problems of selection and space allocation. Not infrequently we found that people with important regional or national stories to tell turned out to be more concerned with what Tech Talk might do with the information than how the national press might handle it. Information previously published elsewhere with little or no impact or readership, we found, was having widespread effect when republished in Tech Talk. Increasingly, Tech Talk found space to republish signed articles of opinion by M.I.T. people that appeared elsewhere, and the practice was received favorably by readers. Facing a coming year of austerity, the task before the News Office in 1975-76 is how to maintain services at or near this past year's levels despite reduced resources.

Some, but by no means all, of the stories that kept M.I.T. in the national news in 1974-75 included: the discovery of the subnuclear 'J' particle by Professor C. C. Ting and others
from the Laboratory for Nuclear Science . . . the student-run Spelling Bee during the January Independent Activities period . . . the talking computer and the use of very long baseline interferometry for geodetic measurements, both from the Research Laboratory of Electronics . . . the Center for Policy Alternatives study of servicing durable consumer goods (refrigerators, etc.) . . . Center for Space Research balloon and satellite studies of intergalactic X-ray sources, including launch of the Center's X-ray detection package aboard the Small Astronomy Satellite-C off the coast of Kenya in Africa . . . the discovery of on-off switching mechanisms in genes by the chemistry and biology group headed by Professor Har Gobind Khorana . . . views of the economy, its ups and downs, by Professor Paul Samuelson of the Department of Economics . . . studies on new mortgage mechanisms to stir home building by Professor Franco Modigliani, his election as president of the American Economic Association, and his call for a $20 billion tax cut early in the year, and, as the recession worsened, his call for a tax cut of $30 to $40 billion . . . development of a subdermal biodegradable birth control technique in the Department of Nutrition and Food Science . . . development of phonoangiographic means for non-invasive studies of the heart in the Clinical Research Center . . . studies by Professor John Lewis in the Department of Earth and Planetary Sciences on the red spot on Jupiter . . . the start of efforts by the M.I.T. Energy Laboratory to develop a system to supply part of the electrical demands of a New York City skyscraper by means of a rooftop solar energy converter . . . studies in the Electronic Systems Laboratory on the electronic future of supermarkets and other E.S.L. studies on the electronic production of newspapers . . . and, prominently, the work of Professor Jack Baldwin in the Department of Chemistry in the development of a synthetic molecule that might serve as the basis for artificial substitutes for red blood cells. M.I.T. feature photographs that made the news wires included, but, once again, were not limited to: Workmen in silhouette washing the windows of Lobby 7 against a setting sun . . . an overhead view of students playing a giant chess game in Lobby 7 using people as the pieces . . . the assembly of a 10-foot mylar balloon into a huge Van de Graaf generator, also in Lobby 7 . . . and a shot of a workman washing the outside of the smaller radome on top of the 22-story Green Building taken from the unlikely vantage point of the even higher weather instrument mast.

A major news event was the announcement in New York of the $225 million M.I.T. Leadership Campaign. M.I.T.'s new Innovation Center also was in the news: first in a laudatory page-one story in the Wall Street Journal, then in a denunciation-by-press release by U. S. Senator William Proxmire, and finally in a strong defense by Dean Alfred H. Keil. M.I.T.'s plan to train nuclear engineers for the Atomic Energy Organization of Iran also drew press attention. Another major, and saddening, story was the death of Dr. Vannevar Bush. These are only samples, but they illustrate the scope and pace of activities that pass through the News Office.
Eileen R. Schuyler, secretaries; Susan E. Walker, editorial secretary in charge of the Calendar of Events and classified advertising; Sally M. Hamilton, editorial assistant assigned primarily to Tech Talk, art and music; and Ellen N. Hoffman, editorial assistant assigned primarily to hometown news.

ROBERT M. BYERS

Campus Information Services

The four offices of the Campus Information Services are the M.I.T. Bulletin, the Design Services, the Information Center, and the Registry of Guests. Over the past year, since becoming Manager of this area, I have come to appreciate in a new light the importance and the subtleties of the different ways in which we at M.I.T. communicate with each other and with those who visit us or seek to join our ranks: in print, in person, through visual design, over telephone wires, on tour around campus. The health of M.I.T. depends more than ever on the basic understanding -- by ourselves and by those outside our campus -- of our basic programs and purposes, our current activities, our history, and our plans for the future. The ability to share this understanding has been an M.I.T. strength in the past and a continuing goal of those of us who work in information services. To accomplish this goal, we work with each other and with others at the Institute. Sometimes this collaboration receives highly visible, tangible recognition; more often -- and more appropriately -- the work that we do seeks to quietly enhance the Institute's programs and sense of community.

Tangible recognition is appreciated, however, and one example this year was the first place in the Communications Award Program of the Council for the Advancement and Support of Education, which cited M.I.T. as having the most effective communications program for prospective students. Our publications -- produced by the Admissions Office, the Design Services, the M.I.T. Bulletin Office, the Financial Aid Office, and the Freshman Advisory Council -- were judged by a panel of students and high school counselors to be "thorough, complete, informative, and candid." Said one judge of the M.I.T. materials: "No gimmicks, no glamour, but lots of straightforward information... blasts the awesome image into enough little pieces that a prospective student could handle it." The $1,500 which accompanies the first place award has been added to the Institute's general scholarship fund.

M.I.T. Bulletin

The M.I.T. Bulletin consists of the General Catalogue, Courses and Degree Programs, the Summer Session Catalogue, the Report of the President and the Chancellor, and the Report of the Treasurer. In addition, the Bulletin Office publishes the Student Directory and other special purpose publications.

This past year saw the completion of a major redesign project for the General Catalogue, Courses and Degree Programs and other admissions-related publications. For the coming year's publications, special efforts are being made to reduce costs while retaining the quality and effectiveness of various issues of the Bulletin.

In March, Janet L. Snover was appointed to the staff as Production Manager of the Bulletin. Her efficient organization of the catalogue production is a testimony not only to her exceptional talents but to her seemingly limitless stores of energy. Special mention should also be made of Michael Blaber, Janet Brown, and Mary Burnley for the care and the quality of their assistance throughout the year in producing these publications.
Design Services

The Office of Design Services -- under the direction of Jacqueline M. Casey -- provides design, editorial, and production service for publications describing the Institute's programs, purpose, and current activities. During 1974-75, the Office completed 346 graphic design and publishing projects. This represents an increase of 49 projects over the previous year.

A major effort in the Office over the past year has been design and production service for publications associated with the M.I.T. Leadership Campaign. Nancy Pokross has devoted the majority of her time to these projects over the past year, and we expect that an increasing portion of her time will be spent on such publications as the campaign progresses.

Among the other major activities of the Office were numerous projects for the Alumni Association, the Corporation, the Council for the Arts, the Independent Activities Period, the Sloan School, and the Special Summer Programs. The extensive communications program of the Alumni Association requires considerable design and production support. In order to provide more comprehensive support for this program and to better coordinate these communications efforts, the Association -- as part of its overall reorganization -- is planning to hire a graphic designer who will work in the Office of Design Services on all publications of the Association.

Well-deserved professional recognition was given this year to Elizabeth Ferry, who was promoted to the administrative staff as Production Manager for the Office.

The graphic designers in the Office continue to draw critical acclaim and professional recognition from organizations outside the Institute. Ralph Coburn was guest lecturer and critic at Yale University in 1975, and Jacqueline Casey continues reviewing government graphics for the National Endowment for the Arts in Washington. The designs of Mr. Coburn and Ms. Casey will appear in the forthcoming 1975 Print Casebooks. Ms. Casey's work appeared in the American Institute of Graphic Arts Communications Graphic Exhibition in New York in April, 1975. The Office was represented in an international exhibit of posters in Dublin in 1975, and the Library of Congress requested 29 posters from Design Services to add to their permanent collection.

Information Center

As in past years, the Information Center provided information on programs and activities to people both inside and outside the Institute, and conducted tours for visitors to the campus. Requests for publications, directions, and information came from students, faculty, staff, and visitors who telephoned or came in to the Center during the day and early evening. During this past year, telephone calls averaged 1,200 during a normal work week, and the distribution of M.I.T. reports, publications, and notices was a constant activity:

- Bulletin 18,990
- Reports 13,256
- Maps, Guides 34,573
- Other Publications 31,168

Weekend and evening operation of the Center this year was continued with the help of students. Between this service and the guided tours, the Center has employed 58 students in part-time jobs during the past year.
During the past summer, visitors to M.I.T. were surveyed to find out who visits M.I.T. and what they are interested in seeing. The survey showed that 70 percent of these visitors were prospective students, their parents and siblings, and that they were interested in everything about M.I.T.: academic, social, and residential. The remaining third of the visitors surveyed were tourists from other parts of the country or abroad, or were families of students in the special summer programs. Geographically, about half of those surveyed were from the Northeast, and almost one-fifth were from foreign countries. The following are figures on the numbers of visitors and prospective students who visited the Center from July, 1974, through June, 1975:

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prospective Students</td>
<td>1,368</td>
</tr>
<tr>
<td>Tourists</td>
<td>2,291</td>
</tr>
<tr>
<td>Special Tours</td>
<td>989</td>
</tr>
<tr>
<td>Foreign Visitors on Special Tours</td>
<td>264</td>
</tr>
</tbody>
</table>

Many visitors expressed an interest in visiting classrooms or laboratories -- an interest which is difficult to meet without disrupting the teaching and research activities of the Institute. The Center, in collaboration with the Bicentennial Visitors Committee, is exploring ways in which visitors might get a "taste" of the research and teaching activities without interfering with the daily life of the Institute. The number of tourists is expected to increase during the national Bicentennial and plans have been made to maintain a visitors information booth in the Rogers Lobby during the summer months of 1975 and 1976.

The Center has established a new master calendar which lists all events and lectures scheduled at M.I.T. This centralized calendar is intended for reference by people planning major events as well as by those interested in attending such activities. It is hoped that a central calendar will help to avoid major conflicts in scheduling events and will further improve communications within the Institute.

In addition to overseeing the operation of the Center, the Director, Mary Morrissey, has coordinated much of the work involving appointments to Institute committees and has been active in a number of special projects, including the M.I.T. Employees Open House and Institute activities relating to the national Bicentennial. As a final note, the Director has mentioned the marvelous esprit-de-corps that exists among the staff in the Center. Kathy Barrett, Terri Priest, and Martha Nikas have been invaluable with their cooperation and assistance in meeting the information needs of visitors and members of the M.I.T. community.

Registry of Guests

The Registry of Guests provides information and support to long- and short-term visitors to the Institute from other countries. These responsibilities include administration of the exchange visitor visa program and of the short-term visitor program and maintenance of a central record of long- and short-term visitors to the Institute. In addition, the Director of the Registry, Carolyn Cox, is responsible for arranging for representation of M.I.T. at major events of other educational institutions and for providing staff support for the Committee on Commencement.

There were 556 non-U.S. citizens working as staff and faculty members at M.I.T. as of November 22, 1974. The work of the Registry of Guests for long-term foreign staff involves advising visitors and their host departments about which type of visa is appropriate and
Institute Information Services

assisting in the preparation of petitions and supporting documentation. Because of employment conditions throughout the world, there is currently quite an increase in the number of foreign visitors who wish to become permanent residents of the United States. When a foreign visitor already in residence wishes to seek permanent residence, the Registry discusses the case with the individual, the supervisor, and the department head in order to prepare as strong a case as possible. It is becoming increasingly difficult to obtain the required certification from the Department of Labor because of the high rates of unemployment in the U.S. In cases where labor certification is denied, the Registry reconfers with the individual and the department to try building a stronger case for review. During the 1974-75 year, 12 petitions were submitted to the Immigration and Naturalization Service, the first of two steps in applying for permanent resident status. Two petitions were resubmitted and eight more are presently in process.

The Registry also acts as an intermediary between the Institute and many international organizations that wish to obtain placement of foreign scholars and lecturers. These include the Institute of International Education, the Commission on the International Exchange of Scholars, the International Atomic Energy Agency, and the International Research and Exchanges Board.

There were 963 short-term foreign visitors in 1974-75, nearly twice as many as the 515 visitors in 1973-74. Four hundred and eighty-five appointments were made for these visitors. Many visitors are scheduled through the Boston Council for International Visitors which will be closing its doors as of September 1, 1975. It is expected that as of that date, the Registry will deal directly with the government agency arranging the visitor's stay, as well as with foreign embassies, international organizations, the Harvard Marshal's Office, and many other groups.

With regard to Commencement, Mrs. Cox has continued (in concert with Miles Cowen) to provide extraordinary support to this occasion. Reviewing the evolution of commencement activities over the years, she has noted the growing informality of the event and has suggested that a less elaborate and lengthy ceremony may be more in keeping with the spirit of the times and the human and financial resources of the Institute.

KATHRYN W. LOMBARDI
(Howard Webber, Director of the M.I.T. Press since 1970, resigned in August, 1974. Vice President Constantine B. Simonides, to whom the Press reports, served as interim Director until the appointment of Frank Urbanowski as the new Director, effective in June, 1975.)

Last year was the twelfth in the history of the M.I.T. Press. It was, without question, a year of crisis, as mounting deficits raised questions about the future and about the very existence of the Press as an independent publishing organization within M.I.T. Some of the financial problems may be traced to developments and to policies which go back several years.

The Press grew very rapidly in the 1960s. In its first seven years (1963-70), the number of new books published increased from 18 to 125 per year and sales grew from $300,000 to $2.6 million. From 1968 to 1970 small surpluses were accumulated in a retained earnings account. Throughout this period, there was an extraordinary build up of assets—in the form of inventories and accounts receivable—mostly financed by borrowing from M.I.T., for which the Press pays interest annually.

An ambitious ten-year plan, prepared in 1967, projected future growth of net sales at a rate of 15-20 percent compounded annually, in order "to sustain increased expenses and to facilitate limited expansion of services and production." In fact, operations expanded, inventories and accounts receivable continued to be built up, and expenses increased; but sales failed to grow at the projected rates. They grew significantly in 1969 and 1970, levelled off in the next two years, and then declined (from $2.7 million) to $2.4 and $2.3 million respectively, in 1973 and 1974. The decline was in part a result of severe cutbacks in purchases of books by libraries, which affected university presses throughout the country.

The gap created by reduced revenues grew wider by inflated manufacturing and operating costs and by increases in the interest rate. In 1974, the annual burden of interest payments on the debt to the Institute was in excess of ten percent of net sales.

Underlying the financial problems and the adverse market conditions of the 1970s were serious deficiencies in internal management controls. Inventory, credit, marketing, and pricing policies failed to respond to the trends of declining markets and inflated costs. Attempts to arrest the growing deficits during the winter and spring of 1974 were hampered by lack of accurate information and by demoralized and divisive attitudes among the staff. In summer, 1974, the Director resigned and the morale and pessimistic outlook reached a low point both in-house and among members of the Institute community, who saw the Press deficits as a continuing financial drain of M.I.T.'s scarce resources.

Fortunately, at the writing of this report, a year later, the picture is dramatically different. Following many long months of hard work and extraordinary effort on the part of everyone associated with the enterprise, the positive signs of a healthy financial turnaround are visible in every aspect of the Press operations. The year 1974-75 saw net sales approaching $3 million, the highest ever in Press history. Net losses from operations were below budgeted levels and impressive gains were made in liquidating assets at full value and in reducing the debt to M.I.T. by a net inflow of cash. To a large extent, the improvement in the financial picture was the result of intensive marketing achievements and of a major repricing (upward) of all Press books, to meet the inflated standards of the market.
In terms of providing for the future, the most noteworthy development of this year was the selection and appointment of Frank Urbanowski as the new Director of the Press, effective in June, 1975. The formal selection process took about seven months, in part because of the enthusiastic response to our announcement by many well-qualified candidates. I was assisted in the selection process by a five-member advisory panel consisting of Professors Stanford Anderson, Michael L. Dertouzos, and Hartley Rogers, Jr.; and Messrs. Jack Schulman and W. Bradford Wiley, all members of the Press Editorial or Management Board. Mr. Urbanowski was our first choice. His background includes a very successful record as editor and publisher with The Macmillan Company. His pragmatic and professional approach and his special interest and demonstrated competence in acquisitions and planning will be especially useful in his new responsibilities. We are confident that under his leadership the Press will grow in excellence and efficiency.

In publishing activities, the year was a productive period of consolidation of many projects that had been initiated earlier, and of modest but significant gains: a total of 135 titles were published under the M.I.T. Press imprint, bringing the total published by the Press to 1,318. Of these 135 new books, 79 were original hardcover editions; 11 were imported and distributed by the Press, and 45 were new paperbacks. In total, about 500,000 books bearing the name of M.I.T. reached readers during the year.

In terms of public acceptance and recognition, the year was no exception to the ones preceding it. The Press continued to distinguish itself, nationally and internationally, by the quality of its books. Reviews appeared in U.S. and foreign journals and in newspapers as various as the Sunday New York Times Book Review, the Village Voice, The Atlanta Constitution, the Milwaukee Sentinel, and Alabama's Anniston Star. We are particularly proud of a silver medal prize, awarded by the Israeli Art Book Biennale to the book, "Is Anyone Taking Any Notice" by Donald McCullin, the only university press book to be recognized. The American Association of University Presses included two books (the maximum per press) in its show, and awarded six other certificates of special recognition and one, a title page, certificate of merit; these awards were more than any other press has received. Graphis Magazine included a review of both the M.I.T. Design Services and the M.I.T. Press graphics, as a portion of a corporate design issue.

The Press operated throughout last year without a professional full-time Director, without an Editor-in-Chief, and without a Marketing Manager. A new Financial Manager arrived on the scene at the beginning of the fiscal year, and there were a few other new members of the staff, all of whom had to become familiar with Press operations while carrying heavy work loads. Owing to budgetary pressures, the size of the staff was cut from 65 to 48 people in a period of less than two years.

Because of the reduced size of the staff and the important vacancies in key leadership positions, departmental lines and responsibilities were intentionally drawn less clearly than had been the case in the past. All of the reports which follow, therefore, represent to some extent the product of a unified effort of the whole Press although reported under the headings of each of its departments.

**Acquisitions**

The resignations of Howard Webber -- who besides being the Director of the Press also was responsible for acquisitions in architecture -- and Arnold C. Tovell, Editor-in-Chief, who was responsible for the social science areas, reduced the acquisitions staff to two editors: Frank Satlow (primarily engineering) and Yale Altman (primarily science). Barbara Ankeny,
who returned to the Press from a six month leave from the editorial department, took on the special post of Acquisitions Coordinator and performed the functions of receiving and responding to new manuscripts, as well as doing special studies for the Director. Because of the reduced staff, subject area responsibilities were extended as three professional staff members attempted to cover all areas of Press publishing.

During the year, all pending publishing projects were reviewed and updated; active proposals were presented to the Editorial Board, and either declined or contracted. Old projects were reactivated or declined, contracts were reviewed and then enforced or terminated, and departmental procedures were overhauled and regularized. Most of the M.I.T. Press Series were reviewed and evaluated by the staff and the Editorial Board.

The Editorial Board reviewed 58 proposals at 17 meetings. Of these, 47 were accepted for publication, eight were declined, and three were deferred pending further information or further discussion. In the past five years, the Board had considered an average of 115 proposals per year and declined an average of four. The decrease in the number of proposals presented to the Board, and the relative increase in the number of projects rejected by the Board, were the result of staff shortages and uncertain standards, in the absence of a Director. Several steps forward were taken, however, in the improvement of the system of preparation and review of dockets. A new publishing proposal format, far more extensive and detailed than the ones previously used, was introduced this year and is now undergoing further revision. Most projects submitted to the Board were in manuscript form, rather than merely proposals of books to be written. Because of the absence of a Director and of a well-formulated publishing plan, the Board often delved into the details of the financial and marketing aspects of each project, in addition to evaluating the content more critically. As this report is written, the new Director, the Press staff, and the Editorial Board are beginning to engage in the development of a comprehensive publication plan, which will guide the direction and the scope of the acquisitions effort in the future.

Professor Rogers, Associate Provost of M.I.T., assumed responsibility as Chairman of the Editorial Board in July, 1974. Professors Anderson (Architecture) and Morris Halle (Linguistics) continued in the second of their three-year terms. Professors John Ross (Chemistry), Daniel M. Holland (Management), and Walter S. Owen (Materials Science and Engineering) were appointed for three-year terms in July, 1974. Professors Peter Elias (Electrical Engineering and Computer Science), and Donald L. M. Blackmer (Political Science) complete three-year terms in July, 1975; Professor Blackmer was asked by the President to continue for another year to help provide continuity, in part because Professors Ross and Elting E. Morison (Humanities) had to leave the Board, owing to other commitments. The Press and the Institute are grateful to all of the members of the Editorial Board, and especially to Professor Rogers, for giving so freely of their time and energy in this transition year.

In addition to those proposals brought before the Board, 200 projects were reviewed by outside readers during the year and a total of about 800 were declined by the acquisitions staff without reference to outside readers. Thirty-six new book contracts were signed during the year, about one-third of them with M.I.T. faculty or other staff members connected with the Institute.

Below is a table showing the percentage breakdown of new titles published each year in certain broad subject categories:
Authors continued to enthusiastically praise the editorial department, which this year brought 15,000 manuscript pages to the degree of polish that has come to be characteristic of the Press. The investment in editorial refinement is considerable, and whether the Press can continue to provide this service for all of its books is an open question.

The editorial department continued to function under the able leadership of Helen Osborne, who, in addition to her regular duties, served this year as personnel representative of the Press at M.I.T., supervisor for all nonprofessional staff and for the staff of the journals department (following the resignation of the Journals Manager), and supervising editor for a number of publishing projects. During spring, 1975, two editors -- Cynthia Ware and Tom McCorkle -- were on special assignment to the marketing department, to assist with special sales efforts and promotions. At the conclusion of the year, Mr. McCorkle was promoted by the Director of the Press to the position of Marketing Manager, in charge of that department.

I would like to pay special tribute in this report to Constance D. Boyd, Senior Editor, who retired at the end of June, 1975. Miss Boyd has been with the Press since its days as the Technology Press under John Wiley & Sons, and has contributed largely to the Press' editing reputation. She will continue to do some freelance editorial work for the Press, and she always will be remembered by generations of Press authors and by other members of our community for the discipline and the standards she brought to scholarly publishing at M.I.T.

Media

Despite a reduction in personnel from 15 people to seven as of September 30, 1974, the design, manufacturing, and scheduling activities of this department were carried out in orderly fashion. One reason for our ability to handle the load was that the number of new books composed by the Press has decreased, although the total number published this year increased, if one includes camera-ready and partially camera-ready books, those distributed and/or imported by the Press, the purchased sheets which are then bound, and photographing from sheets owned by the Press to produce new editions or paperbacks. There are

<table>
<thead>
<tr>
<th>Year</th>
<th>Social Science</th>
<th>Humanities</th>
<th>Engineering</th>
<th>Science and Mathematics</th>
<th>Art and Architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969-70</td>
<td>28%</td>
<td>15%</td>
<td>24%</td>
<td>16.5%</td>
<td>16.5%</td>
</tr>
<tr>
<td>1970-71</td>
<td>26</td>
<td>12</td>
<td>23</td>
<td>26</td>
<td>13</td>
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<tr>
<td>1971-72</td>
<td>22</td>
<td>11</td>
<td>27</td>
<td>27</td>
<td>13</td>
</tr>
<tr>
<td>1972-73</td>
<td>28</td>
<td>14</td>
<td>19</td>
<td>27</td>
<td>13</td>
</tr>
<tr>
<td>1973-74</td>
<td>35</td>
<td>14</td>
<td>19</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>1974-75</td>
<td>32</td>
<td>12</td>
<td>12</td>
<td>25</td>
<td>19</td>
</tr>
</tbody>
</table>
still problems, however, with composition of some very demanding heavily illustrated books (and many M.I.T. Press books fall in this category). Alternative ways of dealing with these problems include rescheduling of projects, reconstituting the in-house manufacturing program, or increasing the budget to provide outside help to accommodate overloads. The best solution to all production problems would be, of course, to be able to schedule books well in advance, based on a long-range acquisitions plan. The complications of late manuscript delivery, adherence to original specifications (e.g., number of illustrations), and time required for authors' alterations would remain; but, given more time to plan, these difficulties would be easier to overcome. The Press intends to move in the direction of more planning -- the sooner the better.

Muriel Cooper, Media Director, and one of the senior members of the management team of the Press, continued her effective work inside the House, and continued also to bring distinction to the Press through her academic and professional achievements in the field of visual design. This year, Ms. Cooper was elected to the Board of Directors of the American Institute of Graphic Arts, was a judge of the Type Directors Club annual show and the Canadian National Book Show, and was appointed a non-resident Fellow of the Center for Advanced Visual Studies.

Within the department, Patricia A. Mahon was promoted to Media Production Manager and Mario G. Furtado was named Media Design Manager.

Marketing

During the past year the marketing department underwent major reorganization, both from the point of view of the division of individual responsibilities of its members and from the point of view of the optimum budgeting of limited funds for sales, advertising, and promotion expenses to support the entire publishing program of the Press.

A number of special studies were initiated, such as analysis of the Press' use of complimentary copies, and a study of the relative merits of investment in advertising versus direct promotions. These and other studies will continue in the months ahead. The tasks of determining what information is appropriate and necessary for intelligent publishing decisions -- and then devising efficient and cost-effective means to make it available -- have occupied much staff time throughout the Press. Partial information systems existed in the past within some of the departments -- notably in the editorial and media -- but they were not integrated to serve the House as a whole.

This problem was especially true in the marketing department where records from previous years were minimal and decisions appeared to have been made without much supporting documentation. It is my impression that as information became more openly available and precise, and as changes were made in methods, procedures, and assignments of new responsibilities to existing and new members of the staff, a sense of growing strength developed in the department and all efforts that contributed to the whole marketing process were pulled together. Instrumental in these changes was the guiding hand of J. Randall Williams, our consultant, who assumed direct supervision of the marketing area for much of the year.

Marketing operations during the year were focused on the use of multiple-title direct-mail promotions. Two major programs and several minor mailing efforts were launched. In January, 1975, a 16-page newsprint tabloid, offering variable discounts on nearly all of the active titles of the Press' backlist, was mailed to about 500,000 potential buyers. This massive sale, under the title of "More is Less" was one of the most successful promotional
undertakings in the history of the Press. Its value was not only in the total dollar volume, which reached the respectable sum of $300,000, but also in the fact that all of the purchases were prepaid cash or credit card sales. Approximately 70,000 books were sold, many of which had been carried in the Press inventory for a long time.

The second major program was a set of six sectional catalogues, in architecture, linguistics, systems theory, mathematics, urban planning, and physics, prepared and mailed to selected groups in each subject. There were 250,000 of these handsome booklets distributed, and the result was approximately $170,000 worth of business, again mostly in cash. The sectional catalogues, so far very successful in reaching the most interested audience for each group of books, will probably be continued through next year.

Everyone in the Press took part in these two promotional programs; but most of the credit for their planning and execution goes to Brooke Stevens, Direct Mail Manager, for the "More is Less" sale, and to Randall Goff, Advertising and Promotions Manager, for the sectional catalogues.

Owing, in part, to shortages in personnel, there were comparatively few individual calls made on the retail trade accounts by sales representatives. Beginning in January, 1975, selling to the trade was strengthened by sharing the services of a West Coast account representative, Judith Kucera, with three other university presses. The whole area of sales representation will be given careful additional thought and planning in the year ahead.

The Press has been active in the field of exhibits, and has had its own exhibit staffed by Press personnel at ten conferences, promoting books to professionals in a number of fields, to librarians, to booksellers, to other publishers, and to the public. An attractive, inexpensive, and simplified display was conceived by the design and marketing departments and has been in use since May. M.I.T. Press books also were displayed in 25 combined exhibits, primarily through the Association of American University Presses. Emily J. Rosenthal, Operations Manager in the marketing department, was primarily responsible for the exhibits program.

The reviewing media -- newspapers, general magazines, special interest periodicals, etc. -- have given strong attention to Press publications throughout the year. On the average, there have been between 30 and 40 reviews received weekly, or close to 1,500 notices this year. The management of publicity and relations with the public media is the responsibility of Anne B. Sayre.

All subsidiary rights activities were consolidated this year into one area, which now includes the handling of foreign publication rights, book clubs, reprint sales, permissions, quality and mass market paperback rights, and serialization. Kirk Adams, new on the staff of the Press, is responsible for this area within the department. The whole area of subsidiary rights will receive more concentrated and detailed attention in the year ahead with a view to substantially increasing the Press' income from these sources.

The M.I.T. Press Limited, a marketing office in London (operated by Graham Voaden and a small staff which also serves the University of Chicago Press and the Harvard University Press) was responsible for sales during the year of nearly $500,000, the highest amount in one year since it was established. The marketing department intends to maintain close cooperation between London and Cambridge on promotional efforts in order to achieve a more efficient and cost-effective operation.
Journals

Four journals are now published by the Press: Linguistic Inquiry, Visible Language, The Journal of Interdisciplinary History, and Cell. Publication of two journals was discontinued this year: Studies in Applied Mathematics is now published by American Elsevier in New York and Public Science, a newsletter, is in the process of negotiation for a new publisher.

A plan for publishing a series of linguistics monographs as supplements to the Linguistic Inquiry journal has been developed by Professor S. Jay Keyser, editor of the journal. The results of this experiment will be studied closely for possible future application in other fields.

The role of the M.I.T. Press journals in general also will be examined carefully in order to develop a stronger, more complementary book and journal program. Efforts in this area are especially promising in the cases of Linguistic Inquiry and Cell. The latter, launched from the Press in January, 1974, under the leadership of Dr. Benjamin M. Lewin as editor, has had a very impressive early career, with subscriptions close to 800 and going up steadily.

In November, 1974, Christine A. Salmon resigned as Journals Manager to attend to her new maternal duties. She was not replaced, pending the arrival of the new Director. In the meantime, Blair Bergstrom has carried the major burden of the administrative support to the journals, with assistance from George Pratt.

Financial and Business

Under the leadership of Michael T. Leonard, the new Financial Manager who joined the Press from previous service in the M.I.T. financial administration, the department has been involved totally in the reorganization and improvement of financial and management systems within the House. Every transaction which reflects on the financial situation of the Press was reviewed and monitored, and the department has initiated, participated in, and/or followed through on every step to establish a management process of maximum information, control, and accountability. Able and generous assistance came to the Press from the Institute's financial offices, under the direction of Frank McGrory, Associate Director in the Office of Sponsored Programs. Frank Conroy joined the Press full time in the fall of 1974, and aided the Financial Manager in a number of ways as a special financial analyst during this year of transition. Richard Salmon continued to serve as credit manager, and this function was significantly strengthened in order to reduce the excessive accounts receivable balance. The myriad of financial transactions throughout the year, as well as the maintenance of the Press accounts, were the responsibility of Cornelius Kiely. He and Mr. Leonard worked closely with the M.I.T. auditors and, as a result, the Press statements at the close of the fiscal year were ready for auditing and certification, thereby eliminating later reviews and post hoc adjustments.

The management of inventory, warehousing, and shipping operations continued to present difficulties which are a chronic and major problem for the Press. While the external fulfillment agent is taking steps to improve service, the Press is now in the process of contracting for alternative warehousing arrangements, in cooperation with the Harvard University Press. We hope that next year's annual report will reflect a record of significant progress on this front.
The M.I.T. Press Management Board, which serves as a board of directors for the Press within the M.I.T. structure, met three times this year in full session, and has established regular quarterly meetings for next year. In this year of major upheaval and redirection, the advice, encouragement, and guidance of the Board have been invaluable.

The members who served on the Management Board in 1974-75 are:

- Paul V. Cusick Vice President for Fiscal Relations
- Michael L. Dertouzos Director, Project MAC Professor, Electrical Engineering and Computer Science
- John M. Deutch Professor, Chemistry
- Richard B. Gladstone Senior Vice President Houghton Mifflin Company, Boston
- John F. Rockart Senior Lecturer, Management
- Hartley Rogers, Jr. Associate Provost and Professor, Mathematics Chairman, Editorial Board, M.I.T. Press
- Jack Schulman Director Cambridge University Press, New York
- Constantine B. Simonides Vice President Chairman

J. Randall Williams, retired Senior Vice President of Little Brown Co., served during most of the year as a part-time consultant to me, in my duties as interim Director of the Press. The Press, and I personally, are in his debt for the untiring assistance, the wisdom, and the cheerful advice he gave to us on all occasions. Without him, the job would probably not have been possible. It certainly would not have been as much fun.

Special thanks also go to Barbara Hoffman who was employed at M.I.T. for 13 months to assist me with Press-related responsibilities, and whose patient, thoughtful, and whole-hearted support and counsel in all aspects of the job set a standard of quality that will long be remembered.

Over the past 12 years the Press has grown in size and reputation. In 1963 it published 18 books under a new imprint, and had net sales for the year of $290,000. This year the Press published 135 books under an imprint that has become well known both nationally and internationally, and had net sales of $2,900,000. In the past months, problems of managing growth, combined with adverse external conditions and serious issues of leadership, became apparent. Steps have been taken to rectify these problems. As I said earlier in this report, the most heartening step to me is the appointment of the new Director and the enthusiastic reception and cooperation he has enjoyed from the Press' competent staff and from M.I.T. and the wider publishing community.

Next year there should be further improvement in all areas of the Press. The operating deficit should be reduced by 1978 to a figure close to the amount of interest on the Press' debt
to the Institute; this means that current operations should be close to a break-even level. As these plans materialize we should settle the question of some form of capitalization to deal with the problem of the interest and the long-range debt obligations. And, of course, the Press must continue to publish with professionalism and distinction the best books in the areas reflected in its past strength and in the intellectual interests of the Institute of which it is a part.

In concluding this account, I would like to add a personal word on the meaning of the past year to me, not as the officer of M.I.T. to whom the Press reports, but as a transient member of this remarkable organization. For the Press, the year has been a period of problems and of some progress in meeting the goal of publishing and marketing worldwide the best books bearing the M.I.T. imprint. For a non-publisher to be a part of this effort was a stretching experience full of learning opportunities, sometimes easy, sometimes hard and painful, but always exciting and eventually rewarding. It is a privilege and a special source of satisfaction to be associated with the men and women of the M.I.T. Press.

CONSTANTINE B. SIMONIDES
The annual reports for the Medical Department -- including the Environmental Medical Service, the Radioactivity Center, and the Arteriosclerosis Laboratory -- and for the Registrar follow my brief comments. In addition to the information regarding the Institute's housing programs set forth below, the separate reports of the Dean for Student Affairs, the Dean of the Graduate School, and the Vice President for Operations cover our student housing programs.

Housing

For several decades, the Institute's undergraduate housing policy has been to provide on-campus housing for up to a total of eight consecutive terms to each undergraduate who desires to live on campus. Full implementation of this policy has rarely been possible because, despite the provision of several new undergraduate residential facilities, demand has outrun supply. Typically, most college transfer students have been denied housing upon their arrival at the Institute, and upperclassmen who have left the Institute housing system for a term or more cannot be accommodated.

Indeed, for the past several years the availability, or lack thereof, of residential space has been the controlling factor in establishment of the size of the freshman class (since freshmen are required to live in an Institute house, a fraternity, the M.I.T. Student House, or at homes of immediate family). In the face of the increasing numbers of qualified applicants, the desire of several academic departments to increase the size of their undergraduate major populations, and the financial problems of the Institute, the present housing policy has come under increasingly heavy scrutiny. Associate Provost Hartley Rogers and I are currently charged with the development and evaluation of alternative approaches for discussion by the Academic Council during early 1975-76.

During this past year, Professor Rogers led a preliminary review effort which provided the basis for establishing the size of the class to enter in September, 1975. Fortunately, the new West Campus house for 300 undergraduates had been under construction and, even more fortunately, construction progress has exceeded expectations so that the entire capacity will be ready for occupancy this fall. We now predict an overcrowding of 50 undergraduates throughout the system this fall if the new class size in September is 1,150, the maximum target figure for admission.

The lack of available gift capital which is so necessary for construction of undergraduate housing has resulted in our not being able to make firm commitments to construct additional housing. Thus, if the current student demand for on-campus housing continues, it will be impossible under our current academic calendar to maintain for more than a few years both our current housing policy and freshman admissions levels in the range of 1,100 per year.

At the graduate level, we have not attempted to provide housing on-campus for all who wish to live on-campus. Instead, we have had the dual development targets of seeking to provide on-campus housing for approximately one-half of the single student population and approximately one-half of the married student population.
With the completion of the new West Campus undergraduate house this September, it will be possible to relocate there the group of undergraduates housed temporarily (for 1974-75) in Ashdown House. Thus, the entire capacity of the completely renovated Ashdown House and the new Tang Hall together will provide on-campus accommodations for single graduate students roughly equivalent to our target. Unfortunately, Eastgate and Westgate provide on-campus accommodations for only about one-quarter of our married student population.

Financial projections on costs of new construction, costs of borrowed capital, and students' rent-paying ability are so dismal that all plans for adding to the on-campus graduate housing stock are dormant.

Because rapidly increasing energy costs this past year required the imposition of large increases in student rents, considerable graduate student attention was focused on housing problems. Threatened rent strikes were averted but there is little doubt that rising costs of living will continue to take increasingly serious tolls in quality of student life and student-administration relationships.

In an effort to address some of these issues, an ad hoc graduate student-administration committee on housing was formed by Dean Irwin W. Sizer. Although communication channels and some good faith were re-established, the group has yet to find the solution to the underlying dilemma faced by individual students as well as the Institute -- expenses are outpacing incomes at an increasing rate.

The downward trends in the economy also resulted in our being unable to make any significant improvements in programs to assist faculty and staff to find satisfactory close-in housing. As examples: the Northgate Community Corporation continues to operate with significant losses and is in the process of divestment, and the development of the Northwest area is essentially at a standstill.

Medical

I believe it appropriate to offer some amplification of the comprehensive report Dr. Albert O. Seeler and his associates have submitted. The recommendation made at the beginning of this academic year by the senior Institute officers and approved by the Executive Committee of the Corporation to permit the offering of the M.I.T. Health Plan to all faculty, staff, and employees is a major decision with significant ramifications. In particular, the Medical Department must find ways to grow in staff, space, and budget to meet the increasing demand for service; and the Department must accomplish this growth at precisely the time that financial problems are forcing cut-backs and retrenchment in many other areas at the Institute.

Fortunately, operating experience to date with the Plan and projections for the future are sufficiently positive to justify continuation of the decision to proceed. Indeed, when viewed as a portion of the Institute's overall health care programs, the Plan's controlled structure of health care appears to offer promise of some cost stabilization. Thus, the Plan's ability to control cost should provide some counterbalance to the extraordinary escalation of costs associated with our Master Medical Program and the more traditional health delivery systems.

Although the driving forces are different than those acting on the health care programs, the Environmental Medical Service is undergoing similar conflicts in meeting escalating demands for services. These conflicts on the staff are posed by the need for economic stringency on the one hand and, on the other hand, by the increased breadth and more stringent standards
of government relation and the expansion into new areas of research by faculty. A prime example of this last phenomenon is the rapid growth in our research programs which are dependent on animals. In his contribution to the report of the Environmental Medical Service, Dr. James G. Fox provides some insight into the associated dilemmas. Fortunately, we now have evolved a rational program of attack.

As a reflection of the emerging complexity in animal-related efforts, effective toward the close of the year, the Office of Institute Veterinarian in the Environmental Medical Service was recast into the Division of Laboratory Animal Medicine within the Medical Department. Dr. Fox will direct this division as Associate Professor and will continue to discharge the responsibilities formerly associated with the title of Institute Veterinarian.

Registrar

During the past decade, the number of the Institute's academic programs has expanded significantly. Increasingly greater flexibility has been provided for all students in curricular structure and in the satisfaction of degree requirements. In addition, the grading system has undergone several expansions and revisions.

While all of these changes have been made in the interests of improving educational programs, they have not been accomplished without significant cost. Costs associated with curriculum development, increased subject offerings, more faculty-student counseling, etc., are reflected in departmental staffing tables and budgets. The Office of the Registrar is one of the central administrative offices whose functions are made increasingly complex by increased variety and flexibility. Some measure of the "academic bookkeeping" problems involved is the single fact that the total number of grades awarded each term is approximately one-half the total number of subject registrations during the term. Put another way, on the average, each student registers for twice the number of subjects for which he ultimately receives grades.

In addition to the problems of maintaining accurate, up-to-date records, the Office of the Registrar -- through the Schedules Office -- is responsible for development of student and classroom schedules which minimize student conflicts, which maximize faculty preferences in teaching times and locations, and which, ultimately, rely upon limited resources in number and kinds of teaching spaces. The development of sophisticated computer-based systems has made it possible for the Registrar's staff to provide support for these changes without an attendant increase in personnel. In fact, in recent years, the total complement of personnel has decreased.

As we have moved over the past few years into increasingly more restrictive financing, the high costs associated with our current registration flexibility have come under increasing scrutiny. Although sparked by financial problems, many faculty groups are now openly addressing the educational wisdom of many of our flexible practices. Although it is too early to predict how these questions will be addressed constructively, it appears quite clear that further developments in flexibility are unlikely and, that in fact some "tightening up" may take place.

KENNETH R. WADLEIGH
All statistics on Registration and Staff in the following tables are given as of the fifth week of the Fall Term, except: 1943-44 as of August 2, 1943; 1944-45 as of November 27, 1944; and 1945-46 as of July 30, 1945.

Table I  Student Registration since the Founding of the Institute*

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of students</th>
<th>Year</th>
<th>Number of students</th>
<th>Year</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1865-66</td>
<td>72</td>
<td>1903-04</td>
<td>1,528</td>
<td>1941-42</td>
<td>3,055</td>
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<tr>
<td>1866-67</td>
<td>137</td>
<td>1904-05</td>
<td>1,561</td>
<td>1942-43</td>
<td>3,048</td>
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<td>1867-68</td>
<td>167</td>
<td>1905-06</td>
<td>1,466</td>
<td>1943-44</td>
<td>1,579</td>
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<td>1868-69</td>
<td>172</td>
<td>1906-07</td>
<td>1,397</td>
<td>1944-45</td>
<td>1,198</td>
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<tr>
<td>1869-70</td>
<td>206</td>
<td>1907-08</td>
<td>1,415</td>
<td>1945-46</td>
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<td>1870-71</td>
<td>224</td>
<td>1908-09</td>
<td>1,461</td>
<td>1946-47</td>
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<td>1871-72</td>
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<td>1909-10</td>
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<td>1947-48</td>
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<td>1919-20</td>
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<td>1923-24</td>
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<td>1962-63</td>
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<td>1925-26</td>
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<td>1963-64</td>
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<td>1926-27</td>
<td>2,671</td>
<td>1964-65</td>
<td>7,151</td>
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<td>1965-66</td>
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*From 1943 to 1946 Army and Navy students are omitted (see Table 3-B in reports for 1943 to 1946).
Table I-A Student Registration in the Summer Session since 1948

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<th>Year</th>
<th>*In Regular Subjects</th>
<th>+In Other Subjects</th>
<th>Year</th>
<th>*In Regular Subjects</th>
<th>+In Other Subjects</th>
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<td>1,719</td>
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<td>1,757</td>
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* Students attending regular subjects from M.I.T. curricula
+ Students attending professional and technical subjects which are not part of M.I.T. curricula and in general carry no academic credit.
<table>
<thead>
<tr>
<th>Table II  Academic Staff Count</th>
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<td><strong>Institute Professors &amp; Lecturers</strong></td>
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<td>Architecture</td>
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<td>Urban Studies and Planning</td>
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<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>School of Engineering</strong></td>
</tr>
<tr>
<td>Aeronautics and Astronautics</td>
</tr>
<tr>
<td>Chemical Engineering</td>
</tr>
<tr>
<td>Civil Engineering</td>
</tr>
<tr>
<td>Electrical Engineering</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
</tr>
<tr>
<td>Metallurgy and Materials Science</td>
</tr>
<tr>
<td>Nuclear Engineering</td>
</tr>
<tr>
<td>Ocean Engineering</td>
</tr>
<tr>
<td>School Professors</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>School of Humanities and Social Science</strong></td>
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<td>Economics</td>
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<td>Political Science</td>
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<td>Psychology</td>
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<td>School Professors</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
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<td><strong>Alfred P. Sloan School of Management</strong></td>
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<td>School of Science</td>
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<td>Biology</td>
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<td>Chemistry</td>
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<td>Mathematics</td>
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<tr>
<td>Meteorology</td>
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<tr>
<td>Nutrition and Food Science</td>
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<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

| Administration                       | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Aerospace Studies                    | -  | - | -  | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 6 | 1 |
| Arteriosclerosis                     | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 5 |
| Athletic                             | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 21 | 15|
| Center for Advanced Engineering Study| -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 2 |
| Center for Advanced Visual Study     | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 10 | 5 |
| Center for Cancer Research           | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 |
| Center for International Studies     | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| Center for Materials Science and Engineering | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| Center for Policy Alternatives       | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 12 | 3 |
| Center for Space Research            | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Center for Transportation Studies    | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Division for Study and Research in Education | 2 | 1 | -  | 1 | - | 2 | - | 1 | - | - | - | - | - | - | - | - | 7 | 1 |
| Electronic Systems Laboratory        | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Harvard-MIT Health Services and Technology | - | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Laboratory of Architecture and Planning | - | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| Laboratory for Nuclear Science       | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 |
| Libraries                            | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 |
| Medical                              | 2  | 1 | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| Military Science                     | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 122 |
| National Magnet Library              | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Naval Science                        | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Operations Research                  | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Project Mac                          | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 |
| Research Laboratory of Electronics   | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 57 |
| Sea Grant Program                    | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| Student Activities                   | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 |
| Urban Systems Laboratory             | -  | - | -  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| **Total**                            | 4  | 3 | -  | 7 | 6 | - | - | 3 | 1 | 10| 19| 29| 3 | - | - | - | 84 | 3 | 311|

| Grand Total                          | 422| 50| 5  | 214| 222| 20 | 21| 108| 12| 62 | 47 | 279| 85 | 1,142| 467| 34 | 3,190| 4 | 78 |

| Faculty Ex-Officio                   | 39 |

The total Faculty is 972
2 Total Teaching Staff is 1672
3 Not included in preceding total
4 Visiting Professors include 45 Professors, 20 Associate Professors, 13 Assistant Professors
Table III  Classification of Students since 1972

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<th>1973-74</th>
<th>1974-75</th>
<th>Course Number</th>
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<td>2 3 4</td>
<td>2 3 4</td>
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<td>Architecture(IV)</td>
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<td>43 42 51</td>
<td>53 46 45</td>
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<td>1 - 2</td>
<td>3 IV-B</td>
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<td>14 18 18</td>
<td>10 23 23</td>
<td>9 20 25</td>
<td>194 XI</td>
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<tr>
<td>Total</td>
<td>44 70 73</td>
<td>53 67 77</td>
<td>63 66 72</td>
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<td>Aeronautics and Astronautics(XVI)</td>
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<td>19 23 16</td>
<td>18 12 21</td>
<td>206 XVI</td>
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<td>- 2 - 2</td>
<td>1 4 1</td>
<td>6 XVI-B</td>
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<td>37 48 48</td>
<td>23 52 54</td>
<td>393 I</td>
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<td>130 122 97</td>
<td>105 132 112</td>
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<td>85 109 94</td>
<td>70 89 128</td>
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<td>1 57 43</td>
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<td>- - 6 6</td>
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<td>9 10 16</td>
<td>8 21 12</td>
<td>138 179 III</td>
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<td>- - 129 129</td>
<td>- - 144 144</td>
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<td>16 11 10</td>
<td>11 15 10</td>
<td>97 133 XIII</td>
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<td>- - 47 47</td>
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<td>344 507 479 1,846 3,176</td>
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Table III-A  Women Students by Schools, Courses, and Years, 1974-75

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<tr>
<td>SCHOOL OF ARCHITECTURE AND PLANNING</td>
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<tr>
<td>Architecture(IV)</td>
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<td>7</td>
<td>6</td>
<td>44</td>
<td>12</td>
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</tr>
<tr>
<td>Total</td>
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<td>11</td>
<td>16</td>
<td>79</td>
<td>21</td>
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<td>SCHOOL OF ENGINEERING</td>
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<tr>
<td>Aeronautics and Astronautics(XVI)</td>
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</tr>
<tr>
<td>Aeronautics and Astronautics(XVI-B Cooperative)</td>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Chemical Engineering(X)</td>
<td>7</td>
<td>4</td>
<td>4</td>
<td>12</td>
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</tr>
<tr>
<td>Chemical Engineering(X-C)</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Civil Engineering(I)</td>
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<td>9</td>
<td>7</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Electrical Engineering(VI)</td>
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<td></td>
</tr>
<tr>
<td>Program 1-Electrical Engineering</td>
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<td>3</td>
<td>2</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>Program 3-Computer Science and Engineering</td>
<td>3</td>
<td>6</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Electrical Engineering(VI-A-Cooperative)</td>
<td>-</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Mechanical Engineering(II)</td>
<td>8</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Mechanical Engineering(II-A)</td>
<td>-</td>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mechanical Engineering(II-B Cooperative)</td>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Metallurgy and Materials Science(III)</td>
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<td>3</td>
<td>3</td>
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<td>8</td>
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<tr>
<td>Metallurgy and Materials Science(III-A)</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ocean Engineering(XIII)</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ocean Engineering(XIII-W-Woods Hole)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Nuclear Engineering(XXII)</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Center for Advanced Engineering Study(EN)</td>
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<tr>
<td>Total</td>
<td>31</td>
<td>44</td>
<td>32</td>
<td>64</td>
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</tr>
<tr>
<td>SCHOOL OF HUMANITIES AND SOCIAL SCIENCE</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics(XIV)</td>
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<td>2</td>
<td>4</td>
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</tr>
<tr>
<td>Foreign Literatures and Linguistics(XXIII)</td>
<td>-</td>
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</tr>
<tr>
<td>Humanities and Engineering(XXI-A)</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Humanities and Science(XXI-B)</td>
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<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Philosophy(XXIV)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>Political Science(XVII)</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>Psychology(IX)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>12</td>
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</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>55</td>
<td>9</td>
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</tbody>
</table>
Table III-A Women Students by Schools, Courses, and Years, 1974-75\(^1\) (continued)

<table>
<thead>
<tr>
<th>ALFRED P. SLOAN SCHOOL OF MANAGEMENT</th>
<th>4</th>
<th>3</th>
<th>4</th>
<th>49</th>
<th>4</th>
<th>64</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management(XV)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>biology(VII)</td>
<td>15</td>
<td>18</td>
<td>23</td>
<td>40</td>
<td>10</td>
<td>106</td>
</tr>
<tr>
<td>biology(VII-A)</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>biology(VII-B)</td>
<td>8</td>
<td>9</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>22</td>
</tr>
<tr>
<td>biology(VII-W-Woods Hole)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Chemistry(V)</td>
<td>7</td>
<td>8</td>
<td>7</td>
<td>25</td>
<td>1</td>
<td>48</td>
</tr>
<tr>
<td>Earth and Planetary Sciences (XII)</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>15</td>
<td>1</td>
<td>32</td>
</tr>
<tr>
<td>Earth and Planetary Sciences(XII-W-Woods Hole)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Interdisciplinary Science Program(XXV)</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Mathematics(XVIII)</td>
<td>12</td>
<td>14</td>
<td>19</td>
<td>10</td>
<td>1</td>
<td>56</td>
</tr>
<tr>
<td>Meteorology(XIX)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Meteorology(XIX-W-Woods Hole)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Nutrition and Food Science(XX)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>43</td>
<td>7</td>
<td>50</td>
</tr>
<tr>
<td>Physics(VIII)</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>13</td>
<td>2</td>
<td>37</td>
</tr>
<tr>
<td>Health Sciences and Technology(HST)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>54</td>
<td>63</td>
<td>73</td>
<td>158</td>
<td>30</td>
<td>378</td>
</tr>
</tbody>
</table>

| Undesignated                        | 50|    |    |    |    | 50 |
| First Year                          | 211|    |    |    |    | 211|
| Grand Total                         | 211| 155| 127| 132| 405| 81 | 1111|

1 Included also in Table III

35 Special Undergraduate Students are included, 30 of whom are registered as Second Year Undesignated.
### Table III-B Special Students by Schools, Courses and Years, 1974-75

<table>
<thead>
<tr>
<th>Course</th>
<th>Year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>School of Architecture and Planning</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Architecture(IV)</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Urban Studies and Planning(XI)</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td><strong>School of Engineering</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aeronautics and Astronautics(XVI)</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Chemical Engineering(X)</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Civil Engineering(I)</td>
<td>51</td>
<td>51</td>
</tr>
<tr>
<td>Electrical Engineering(VI,VII-1,VII-3)</td>
<td>54</td>
<td>58</td>
</tr>
<tr>
<td>Mechanical Engineering(II,II-A)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Metallurgy and Materials Science(III)</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Ocean Engineering(XIII)</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Nuclear Engineering(XXII)</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Center for Advanced Engineering Study(EN)</td>
<td>66</td>
<td>66</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>226</td>
<td>231</td>
</tr>
<tr>
<td><strong>School of Humanities and Social Science</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics(XIV)</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Foreign Literatures and Linguistics(XXIII)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Humanities and Engineering or Science (XXI-A, XXI-B)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Philosophy(XXIV)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Political Science(XVII)</td>
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</tr>
<tr>
<td>Psychology(IX)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>27</td>
<td>30</td>
</tr>
<tr>
<td><strong>Alfred P. Sloan School of Management</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management(XV)</td>
<td>36</td>
<td>39</td>
</tr>
<tr>
<td><strong>School of Science</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biology(VII,VII-B)</td>
<td>26</td>
<td>29</td>
</tr>
<tr>
<td>Chemistry(V)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Earth and Planetary Sciences(XII)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Mathematics(XVIII)</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Meteorology(XIX)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Nutrition and Food Science(XX)</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Physics(VIII)</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Health Sciences and Technology(HST)</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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</tr>
<tr>
<td><strong>Undesignated</strong></td>
<td>71</td>
<td>71</td>
</tr>
<tr>
<td><strong>First Year</strong></td>
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</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td>534</td>
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</table>

1 Included also in Table III
### Table IV  Continued, Former, and New Students

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Continued Students</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate and graduate students registered at the end of the last academic year (including special students)</td>
<td>5,474</td>
<td>5,332</td>
<td>5,337</td>
<td>5,426</td>
<td>5,513</td>
</tr>
<tr>
<td><strong>Non-continued Students</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Former undergraduates and graduate students who previously attended the Institute but were not registered at the end of the last academic year (including special students)</td>
<td>304</td>
<td>291</td>
<td>273</td>
<td>306</td>
<td>249</td>
</tr>
<tr>
<td>Undergraduate students who enrolled for the first time since secondary school (excluding special students)</td>
<td>942</td>
<td>979</td>
<td>1,041</td>
<td>893</td>
<td>1,033</td>
</tr>
<tr>
<td>Undergraduate students who enrolled for the first time at the Institute and who transferred from another collegiate institution (excluding special students)</td>
<td>102</td>
<td>90</td>
<td>104</td>
<td>85</td>
<td>99</td>
</tr>
<tr>
<td>Graduate students who enrolled for the first time at the Institute (excluding special students)</td>
<td>759</td>
<td>786</td>
<td>883</td>
<td>884</td>
<td>849</td>
</tr>
<tr>
<td>Special undergraduate and graduate students with no previous Institute registration</td>
<td>218</td>
<td>239</td>
<td>212</td>
<td>294</td>
<td>307</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7,799</td>
<td>7,717</td>
<td>7,850</td>
<td>7,888</td>
<td>8,050</td>
</tr>
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</table>
## Table V  Regular Students from Other Colleges and Graduates of M.I.T. Classified by Schools and Courses 1974-75

<table>
<thead>
<tr>
<th>School of Architecture</th>
<th>Entered with no previous degree</th>
<th>Entered with Bachelor's degree from other colleges</th>
<th>Entered Graduate School with Bachelor's degree from M.I.T.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture(IV,IV-B)</td>
<td>21</td>
<td>104</td>
<td>39</td>
</tr>
<tr>
<td>Urban Studies and Planning(XI)</td>
<td>4</td>
<td>88</td>
<td>17</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>192</strong></td>
<td><strong>56</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School of Engineering</th>
<th>Entered with no previous degree</th>
<th>Entered with Bachelor's degree from other colleges</th>
<th>Entered Graduate School with Bachelor's degree from M.I.T.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeronautics and Astronautics(XVI, XVI-B)</td>
<td>4</td>
<td>97</td>
<td>33</td>
</tr>
<tr>
<td>Chemical Engineering(X,X-C)</td>
<td>12</td>
<td>103</td>
<td>42</td>
</tr>
<tr>
<td>Civil Engineering(I)</td>
<td>17</td>
<td>169</td>
<td>44</td>
</tr>
<tr>
<td>Electrical Engineering(VI,VI-1, VI-3,VI-A)</td>
<td>60</td>
<td>254</td>
<td>208</td>
</tr>
<tr>
<td>Mechanical Engineering(II,II-A, II-T)</td>
<td>21</td>
<td>164</td>
<td>62</td>
</tr>
<tr>
<td>Metallurgy and Materials Science (III,III-A)</td>
<td>5</td>
<td>95</td>
<td>39</td>
</tr>
<tr>
<td>Nuclear Engineering(XXII)</td>
<td>-</td>
<td>116</td>
<td>22</td>
</tr>
<tr>
<td>Ocean Engineering(XIII,XIII-A, XIII-B,XIII-C,XIII-W)</td>
<td>8</td>
<td>156</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>127</strong></td>
<td><strong>1,154</strong></td>
<td><strong>466</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School of Humanities and Social Science</th>
<th>Entered with no previous degree</th>
<th>Entered with Bachelor's degree from other colleges</th>
<th>Entered Graduate School with Bachelor's degree from M.I.T.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economics(XIV)</td>
<td>7</td>
<td>105</td>
<td>6</td>
</tr>
<tr>
<td>Foreign Literatures and Linguistics(XXIII)</td>
<td>-</td>
<td>29</td>
<td>4</td>
</tr>
<tr>
<td>Humanities and Engineering or Science(XXI-A,XXI-B)</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Philosophy(XXIV)</td>
<td>-</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>Political Science(XVII)</td>
<td>1</td>
<td>78</td>
<td>11</td>
</tr>
<tr>
<td>Psychology(IX)</td>
<td>-</td>
<td>23</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11</strong></td>
<td><strong>254</strong></td>
<td><strong>28</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alfred P. Sloan School of Management</th>
<th>Entered with no previous degree</th>
<th>Entered with Bachelor's degree from other colleges</th>
<th>Entered Graduate School with Bachelor's degree from M.I.T.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management(XV)</td>
<td>4</td>
<td>280</td>
<td>68</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School of Science</th>
<th>Entered with no previous degree</th>
<th>Entered with Bachelor's degree from other colleges</th>
<th>Entered Graduate School with Bachelor's degree from M.I.T.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology(VII,VII-A,VII-B,VII-W)</td>
<td>19</td>
<td>110</td>
<td>17</td>
</tr>
<tr>
<td>Chemistry(V)</td>
<td>11</td>
<td>166</td>
<td>3</td>
</tr>
<tr>
<td>Earth and Planetary Sciences(XII, XII-W)</td>
<td>2</td>
<td>91</td>
<td>29</td>
</tr>
<tr>
<td>Interdisciplinary Science Program(XXV)</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mathematics(XVIII)</td>
<td>27</td>
<td>103</td>
<td>18</td>
</tr>
<tr>
<td>Meteorology(XIX,XIX-W)</td>
<td>-</td>
<td>45</td>
<td>7</td>
</tr>
<tr>
<td>Nutrition and Food Science(XX)</td>
<td>-</td>
<td>101</td>
<td>34</td>
</tr>
<tr>
<td>Physics(VIII)</td>
<td>27</td>
<td>160</td>
<td>86</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>87</strong></td>
<td><strong>776</strong></td>
<td><strong>194</strong></td>
</tr>
</tbody>
</table>

| Undesignated       | 4                              | -                                                 | -                                                         |

| Grand Total       | 258                             | 2,656                                             | 812                                                       |
Table VI  List of Colleges and Universities with Number of Graduates
Entering the Institute as Regular Students, 1974-1975 1

<table>
<thead>
<tr>
<th>College Name</th>
<th>Number of Graduates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akron, University of</td>
<td>1</td>
</tr>
<tr>
<td>Alabama Agricultural and Mechanical University</td>
<td>1</td>
</tr>
<tr>
<td>Alaska, University of</td>
<td>1</td>
</tr>
<tr>
<td>Alfred University</td>
<td>2</td>
</tr>
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| Total Graduates                                      | 219       |
| Grand Total                                          | 1,040     |

1 Graduates of 210 Colleges and Universities in the United States and 126 Foreign Colleges entered the Institute.
### Table VII Geographic Distribution of Students, 1974-1975

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*Country of Citizenship*
Table VIII  Number of Degrees Awarded in September 1974, February 1975, and June 1975

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| School of Engineering               |      |      |                |               |         |       |       |       |
| Aeronautics and Astronautics        | 3    | 1    | 19             | 12            | 16      | -     | -     | 1     |
| Ceramics                            | -    | -    | 2              | -             | -       | -     | -     | -     |
| Chemical Engineering                | 1    | 10   | 25             | 4 8 5         | -       | -     | -     | 2     |
| Undesignated                        | -    | 1    | 9              | -             | -       | -     | -     | -     |
| Chemical Engineering Practice      | -    | -    | -              | -             | -       | 2     | 2     | 15    |
| Civil Engineering                   | 3    | 17   | 32             | 25 30 35      | -       | -     | -     | 42    |
| Undesignated                        | -    | 1    | 1              | -             | -       | -     | -     | 1     |
| Electrical Engineering              | 23   | 35   | 168            | -             | -       | -     | 12    |
| Environmental Engineer              | -    | -    | -              | -             | -       | -     | 1     |
| Mechanical Engineering              | 4    | 6    | 39             | 18 19 30      | -       | -     | -     | 27    |
| Undesignated                        | 2    | 1    | 7              | -             | -       | -     | -     | 2     |
| Materials Engineering               | -    | -    | -              | -             | 2       | -     | -     | 1     |
| Materials Science                   | -    | -    | 1              | -             | 3       | -     | -     | 6     |
| Metallurgy                           | -    | -    | 1              | 3             | 1       | -     | -     | 5     |
| Metallurgy and Materials Science    | 2    | 1    | 8              | -             | -       | -     | -     | 5     |
| Undesignated                        | -    | 1    | 1              | -             | -       | -     | -     | 1     |
| Naval Architecture and Marine Engine| 1    | 1    | 5              | 6 5 12        | -       | -     | -     | 8     |
| Nuclear Engineering                 | -    | 1    | 2             | 12 8 15       | -       | -     | -     | 17    |
| Ocean Engineering                   | -    | 3    | 7              | 3 8 9         | -       | -     | -     | 9     |
| Polymers                            | -    | -    | 1              | -             | -       | -     | -     | 1     |
| Shipping and Shipbuilding Management| -    | 1    | 3              | 3             | -       | -     | -     | 3     |
| Textile Technology                  | -    | 1    | 1              | 1             | -       | -     | -     | 2     |
| Total                               | 39   | 77   | 321            | 118 138       | 197     | -     | -     | 28    |

Total 623
| School of Humanities and Social Science |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Economics                             | 1 | 4 | 17 | 1 | - | - | - | - | - | - | - | - | - | - | 8 | 1 | 8 | - | - | - | 10 | 5 | 25 |   |
| Humanities and Engineering            | - | - | 2  | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 6 | 14 |   |
| Humanities and Science                | 1 | 6 | 14 | - | - | - | - | - | - | - | - | - | - | - | - | 7 | - | 3 | - | - | - | 8 | 2 | 4  |   |
| Linguistics                           | - | - | - | - | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 2  |   |
| Philosophy                            | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 1 | 2  |   |
| Political Science                     | 3 | 3 | 4  | 3 | 6 | 4 | - | - | - | - | - | - | - | - | - | 4 | 2 | 1 | - | - | - | 10 | 11 | 11 |   |
| Psychology                            | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 3 | - | - | - | - | - | 1 | 3 | -  |   |
| Total                                 | 5 | 13| 37 | 7 | 8 | 6 | - | - | - | - | - | - | - | - | 21| 7 | 13| - | - | - | 33| 28| 56 |   |
| Alfred P. Sloan School of Management  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 19| 30| 211 |
| School of Science                     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Biochemical Engineering               | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |   |
| Biology                               | - | - | - | - | 1 | 1 | 4 | - | - | - | - | - | - | - | 5 | 5 | 5 | - | - | - | - | - | - | 6 | 6 | 9  |
| Chemistry                             | 2 | 11| 32 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 11| 32 |
| Earth and Planetary Sciences          | 1 | 14| 38 | 2 | 1 | 5 | - | - | - | - | - | - | - | - | 16| 9 | 15| - | - | - | 19| 24| 58 |
| Food Science and Technology           | 1 | 3 | 20 | 3 | 1 | 3 | - | - | - | - | - | - | - | - | - | 4 | 6 | 2 | - | 1 | 1 | 8 | 11| 26 |
| Interdisciplinary Science Program     | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Life Sciences                         | 2 | 21| 80 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 16| 80 |
| Mathematics                           | 5 | 19| 83 | - | 1 | 4 | - | - | - | - | - | - | - | - | 3 | 2 | 1 | - | - | - | 8 | 22| 98 |
| Meteorology                           | - | - | - | - | 2 | 5 | 1 | - | - | - | - | - | - | 3 | 2 | - | - | - | - | - | 5 | 7 | 1  |
| Nutrition and Food Science            | - | - | - | 3 | 4 | 3 | - | - | - | - | - | - | - | - | 2 | 5 | 3 | - | - | - | 2 | 5 | 3  |
| Nutritional Biochemistry and Metabolism| - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 4 | 3  |
| Oceanography                          | - | - | - | - | - | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 2 |   |
| Physics                               | 5 | 10| 65 | 7 | 3 | 8 | - | - | - | - | - | - | - | - | 8 | 3 | 1 | 6 | - | - | 20| 16| 89 |
| Total                                 | 16| 79| 324| 19| 18| 31| - | - | - | - | - | - | - | - | 41| 32| 52| - | 1 | 1 | 76| 130| 408|
| Operations Research                   | - | - | - | 4 | 2 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 8 | 8 | 13 |
| Without Course Specification          | - | - | - | 8 | 8 | 13| - | - | - | - | - | - | - | - | - | - | - | - | - | - | 8 | 8 | 13 |
| Awarded jointly with Woods Hole       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Oceanographic Institution             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Earth and Planetary Sciences          | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 |
| Meteorology                           | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Biology                               | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Ocean Engineering                     | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 1 | - | - | - | 3 |   |
| Grand Total                           | 65| 193| 769| 168| 191| 408| 9 | 16| 40 | 7 | 3 | 14| 28| 23| 56| 102| 96| 114| 14 | 20| 16 | 393| 542| 1,417|
Table IX  Number of Degrees of Bachelor of Science Awarded

All statistics are arranged by schools as of the current year. During the years 1868-1949 the general division were Architecture, Engineering and Science. In 1950 the School of Humanities and Social Studies was established, and in 1951 the School of Industrial Management (after 1963 the Alfred P. Sloan School of Management) was added.

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Total                               | 25      | 168     | 369     | 1,157     | 1,846   | 2,378   | 3,888   | 3,179    | 4,791   | 4,967   | 4,012  | 1,981 | 28,761| 388 | 412 |

*Includes those in non-science fields.
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<tr>
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<tr>
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</tr>
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<td>or Science</td>
</tr>
<tr>
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<tr>
<td>Philosophy</td>
</tr>
<tr>
<td>Political Science</td>
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<table>
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<th>Alfred P. Sloan School of Management</th>
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<tr>
<td>Business and Engineering Administration</td>
</tr>
<tr>
<td>Management</td>
</tr>
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<table>
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<tr>
<td>Chemistry</td>
</tr>
<tr>
<td>Earth and Planetary Sciences</td>
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<tr>
<td>Undesignated</td>
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<tr>
<td>Food Technology and Biochemical Engineering</td>
</tr>
<tr>
<td>General Science or General Course</td>
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<tr>
<td>Interdisciplinary Science Program</td>
</tr>
<tr>
<td>Life Sciences</td>
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<td>Meteorology</td>
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<table>
<thead>
<tr>
<th>Grand Total</th>
</tr>
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</table>

* Includes only February and June degrees
+ Two received the degree in Naval Architecture, Course XIII-B, in 1916 and three in 1917
1 See also Table XI
2 Prior to 1923 degrees were awarded in Architecture
3 Prior to 1909 this course was designated as Option 3 (Electrochemistry) or Physics
4 Prior to 1938 these degrees were included in Mining Engineering and Metallurgy; changed from Metallurgy to Metallurgy and Materials Science, January 1968
5 Prior to 1958 these degrees were included in General Engineering and General Science or General Course
6 Changed to Alfred P. Sloan School of Management after 1963
7 Changed to Life Sciences beginning January 1962
8 Changed from Geology and Geophysics to Earth Sciences in February 1961, changed from Earth Sciences to Earth and Planetary Sciences in February 1970
9 Prior to September 1965, these degrees were included in Economics, Politics and Engineering or Science
10 Prior to 1959, Business and Engineering Administration, changed from Industrial Management to Management in February 1967
11 Prior to 1960, Aeronautical Engineering
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<th>Calendar year since 1971</th>
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**School of Engineering**

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<tr>
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<td>Electrochemical Engineering</td>
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<td>Fuel and Gas Engineering</td>
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<td>Naval Construction and Engineering</td>
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<td>Sanitary Engineering</td>
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<td>Textile Technology</td>
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¹ School of Architecture and Planning includes Architecture and Architectural Engineering.

Table X: Number of Degrees of Master of Science Awarded
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<td>514</td>
<td>647</td>
<td>324</td>
<td>2,113</td>
<td>72</td>
</tr>
</tbody>
</table>

| Operations Research                   |    |    |    |    |    |    | 708   | 73    | 778  | 733 | 599 |
| Without Course Specification          | -  | -  | 5  | 308 | 263 | 123 | 357   | 299  | 191  | 1,546 | 56 | 48 | 37 | 29 | 21 |
| Grand Total                           | 2  | 21 | 121 | 274 | 1,544 | 2,083 | 2,948  | 5,286 | 7,061 | 3,531 | 22,871 | 708 | 737 | 778 | 733 | 599 |

* Includes only February and June degrees
1 See also Table XI
2 Prior to 1923 degrees were awarded in Architecture
3 Prior to 1959 included in Chemical Engineering
4 Prior to September 1964 included in Economics, Politics and Engineering or Science
5 Considered Engineering until 1950
6 Considered Engineering until 1956
7 Prior to September 1965 these degrees were included in Economics, Politics and Engineering or Science
8 Prior to February 1967 Industrial Management
9 Changed to Earth and Planetary Sciences beginning February 1970
10 Includes six degrees in Political Science awarded 1965
11 Prior to 1960 Aeronautical Engineering
12 Includes degrees in Biochemistry and Biophysics
<table>
<thead>
<tr>
<th>Table XI</th>
<th>Number of Degrees of Bachelor and Master in Architecture and Bachelor and Master in City Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total by decade</td>
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<td>1921-30 1931-40 1941-50 1951-60 1961-70 1971-</td>
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<td>Master of Architecture in Advanced Studies</td>
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<td>Grand Total</td>
<td>63 259 299 566 577 347 2,111 65 74 70 65 73</td>
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</table>

* Includes only February and June degrees
1 From 1935 to 1944, Bachelor of Architecture in City Planning
2 Degree of Bachelor in Architecture changed to degree of Master of Architecture in June 1972
3 Degree of Master in Architecture changed to degree of Master of Architecture in Advanced Studies in June 1972
<table>
<thead>
<tr>
<th>Table XII  Number of Degrees of Engineer Awarded</th>
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<tbody>
<tr>
<td>Total by decade</td>
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<tr>
<td>1949-60</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
</tr>
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<td>Engineer in Aeronautics and Astronautics</td>
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<td>Civil Engineer</td>
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<td>Mechanical Engineer</td>
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<tr>
<td>Metallurgical Engineer</td>
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<tr>
<td>Meteorologist</td>
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<td>Naval Architect</td>
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<tr>
<td>Nuclear Engineer</td>
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<td>Ocean Engineer</td>
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<tr>
<td>Sanitary Engineer</td>
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<tr>
<td>Total</td>
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<tr>
<td>Awarded jointly with Woods Hole</td>
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* Includes only February and June degrees
1 Prior to 1960 Aeronautical Engineer
2 Degree discontinued after 1955
3 Degrees discontinued after 1964
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<table>
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<th>Total by decade</th>
<th>Calendar year since 1971 (included in decade total)</th>
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</tbody>
</table>

* Urban Studies and Planning includes urban planning.  
7 Aeronautics includes aerospace.  
8 Ocean Engineering includes environmental engineering.  
3 Metallurgy and Materials Science includes mining.  
4 Sanitary Engineering includes environmental engineering.  
5 Political Science includes public administration.  
9 Psychology includes psychological services.
## Alfred P. Sloan School of Management

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* Awarded jointly with Woods Hole Oceanographic Institution

| Biology | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - |
| Earth and Planetary Sciences | - | - | - | - | - | - | - | - | 4 | 14 | 18 | - | 2 | 6 | 2 | 4 |
| Meteorology | - | - | - | - | - | - | - | - | 1 | 7 | 8 | 4 | 2 | - | - | 1 |
| Ocean Engineering | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - |
| Total | - | - | - | - | - | - | - | - | 5 | 23 | 28 | 4 | 4 | 6 | 2 | 7 |
| Grand Total | 8 | 29 | 91 | 258 | 447 | 979 | 2,504 | 1,543 | 5,859 | 366 | 336 | 329 | 302 | 210 |    |    |

* Includes only February and June degrees
+ Previously included in Industrial Economics
1 Changed from Industrial Economics to Economics 1966
2 Changed from Industrial Management to Management February 1967
3 Includes Ceramics
4 Changed from Geology and Geophysics to Earth and Planetary Sciences 1970
5 Beginning 1967-68 included in Earth and Planetary Sciences or Meteorology
6 Changed from City and Regional Planning to Urban Studies and Planning September 1969
7 Prior to 1960 Aeronautical Engineering
8 Changed from Naval Architecture and Marine Engineering to Ocean Engineering September 1971
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| **Grand Total** | **7** | **72** | **214** | **364** | **723** | **871** | **282** | **2,533** | **62** | **80** | **53** | **51** | **36** |

* Includes only February and June degrees
1 Prior to 1960 Aeronautical Engineering
2 Changed from Geology and Geophysics to Earth and Planetary Sciences 1970
3 Beginning 1967-68 included in Earth and Planetary Sciences or Meteorology
4 Changed from Naval Architecture and Marine Engineering to Ocean Engineering in September 1971
Table XV  Summary of Degrees Awarded  
(1868-1975)

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* See 1959 Report of the Registrar for details

WARREN D. WELLS
Medical Department

This has been a busy year for the Medical Department. In addition to the increase in enrollment in the M.I.T. Health Plan, there also has been an increase in utilization of the medical services by the other members of the M.I.T. community. Arrangements to include Charles Stark Draper Laboratory, Inc. employees in the Health Plan were completed early in the year, and 200 members were accepted to reach our quota of 1,200 subscribers for the pilot phase. We are pleased that after reviewing the first year and a half of the Health Plan's operation, the M.I.T. administration decided to accept it as a permanent part of the health services for employees and removed the pilot phase limitation on the number of subscribers. Since this decision, another 200 subscribers have been enrolled from the waiting list. Currently, there are 1,400 subscribers and, with their dependents, about 3,600 members. Further increase in the number of subscribers must await additional space. Planning for the provision of approximately 2,500 net square feet of temporary space is under way.

Lack of space continues to be the most critical problem for the Medical Department. Most of our ambulatory care is given in Building 11, the Homberg Memorial Building, but some is provided in the M.I.T. Infirmary, which formerly was the Sancta Maria Hospital. This is a very old structure which does not meet modern standards for a medical facility. During the year, the conference room and part of the waiting room on the third floor of Building 11 were converted into offices for the gynecological service, and we now have to depend on other departments to provide us with space for committee and staff meetings. Our need for a new facility is urgent, and we hope that planning for this will begin in the near future. Based on the experience of the Kaiser-Permanente Foundation, we are convinced that the Health Plan can pay for its share of new facilities, but funding will be needed for the student and employee shares.

In order to conform with Federal standards for the administration of hospitals, a new governing board for the Medical Department was established during the year. This board, which reports to the Corporation, is called the Medical Administrative Board and is made up of three members of the Corporation, three members of the M.I.T. administration, and three consumers. The board will meet at least quarterly to review all matters relating to M.I.T. Health Services and to make appropriate recommendations concerning policies and operations of the Health Services.

Several years ago, a Medical Advisory Committee was established by the Medical Department to serve as a vehicle for consumer advice and complaints. This year the committee was made an official Institute committee with appointments by the President. The committee is composed of representatives of the various consumer groups served by the Medical Department, including the Health Plan. The chairperson is also a member of the Medical Administrative Board. We have found this committee to be very helpful, both in its function as ombudsman and in the evaluation of problems such as the selection of appropriate student hospital and accident insurance.

The computer program, designed to gather administrative and diagnostic data, now serves us well under the direction of Andrew M. Thomson. He is continuing to develop the program to make it even more useful. This year, there were a total of 95,688 visits to the Medical Department, an increase of about 16 percent over last year. About ten percent of the visits were from Health Plan dependents. The off-hours clinic visits at the Infirmary
rose from 6,157 visits to 7,001, an increase of 14 percent comparable to that of the general clinic visits. Interestingly, ten percent of the visits were from Health Plan dependents, also comparable with the experience of the daytime clinic. The increased use of the off-hours clinic by M.I.T. employees is impressive, rising 150 percent in the past four years, probably reflecting, in part, the decrease in availability of private medical care in the outside community. The number of visits to the Lincoln Laboratory Clinic was 6,226, about the same as in 1973-74. Including the off-hours clinic and the Lincoln Laboratory, the total number of visits to the Medical Department for the year was 108,915.

While all our clinics are very busy, the increase in the use of the gynecological service is dramatic. In 1973-74, the number of visits increased by 86 percent and in 1974-75, the increase was 40 percent. Fortunately, excellent new facilities for the gynecological service became available during the year, increasing the dignity and efficiency of the operation. However, we have not been able to obtain enough qualified professional staff time to meet our needs because of the national shortage of well trained gynecologists. Urgent problems are handled promptly but there is a distressingly long waiting period for patients who do not need immediate attention. A highly trained gynecological nurse-practitioner will join us on July 1, 1975, and we will continue to search for additional physician time.

As noted last year, an increasing amount of time is required of professional and support staff to comply with the continuing growth of complex Federal and state regulations. Demands on the Committee on the Use of Humans as Experimental Subjects have increased dramatically during the year to the point where the chairman of the committee, Dr. Warren Point, is devoting about one-third of his time to the work. Other members of the Department also contribute a great deal of their time. This committee must function if the Institute is to continue research involving human subjects, whether it be in nutrition or social science. The committee has no direct relation to the clinical services of the Medical Department. Hopefully in the coming year, the committee will be restructured so that members of the Medical Department will not have to devote so much time to it.

Personnel

Staff appointments during the year were as follows: Alan H. Bennett, M.D., Urologist; Barbara V. Cholakos, B.S., Nutritionist; Joel L. Dunsky, D.D.S., Dentist; Mary Lou P. Every, B.S., Nutritionist; James G. Fox, D.V.M., Ph.D., Veterinarian; David L. Friedman, O.D., Optometrist; H. Harry Funkenstein, M.D., Neurologist; Thomas H. Glick, M.D., Neurologist; Marguerite Heywood, M.S., Assistant for Health Information and Education; Michael A. Kane, M.D., Physician; Walter H. Kunisch, D.D.S., Dentist; Charles S. Langston, M.D., Radiologist; Noemi M. Pedraza, M.D., Physician; Francis Renna, M.D., Dermatologist; David P. Richman, M.D., Neurologist; Albert B. Samaraweera, M.D., Psychiatrist; Kenneth A. Stampfer, M.D., Ophthalmologist; and Elliott L. Thrasher II, M.D., Orthopedic Surgeon. Elizabeth A. O'Brien was promoted to Assistant Administrative Officer for the Environmental Medical Service. Resignations during the year included: Steven Aron, M.D., Ophthalmologist; George Blackburn, M.D., Surgeon; Ching-piao Chien, M.D., Psychiatrist; Louise A. Dierker, M.D, Psychiatrist; Garo H. Garabedian, M.D., Physician; Howard McIntyre, M.D., Neurologist; Donald Osterberg, M.D., Neurologist; Eric Radin, M.D., Orthopedic Surgeon; and Sanford M. Reder, M.D., Physician.

Physician Patricia H. Benedict, M.D., retired. Karen Holmes, M.C.P., was promoted from Assistant to Coordinator for Health Information and Education. The appointment of Wade Rockwood, M.D., was changed to Psychiatrist (full-time).
Employee Health Program

Dr. Melvin H. Rodman reports that during 1974-75 this area of activity completed a change in technique which was initiated three years ago. All health evaluations of applicants for employment, workers in some hazardous occupations, and employees who have reached retirement age are now carried out by utilizing data acquired by questionnaires, tests, and other observations which do not require physicians. The information thus gathered is reviewed and interpreted by a physician and, in some instances, further examination by the doctor is performed. Although the reviewing process is more demanding than formerly, the net effort is a substantial reduction in the physician time necessary to perform these health evaluations.

This method of performing health evaluations also has been utilized for employees who are invited periodically to have examinations. These people also, however, have been seen routinely by a physician after the tests and observations had been performed. This combination of data-acquisition by machines, questionnaires, and non-physicians, together with a brief physician visit, is being viewed as a possible method of standardizing and rationalizing the large number of health survey examinations performed in this Department every year.

Because of differences in methods of gathering statistics, precise comparisons of levels of activity in the Employee Health Program area are not possible. Compared with the 1972-1973 period, however, it is apparent that there has been a reduction of about 6 percent in the number of preemployment examinations. This doubtless reflects the accommodation of the Institute to the economic situation. There has been a steady increase in the number of patients requesting health surveys on their own initiative. Eight hundred and sixty such examinations were done during 1974-75. These, with the health surveys performed for faculty, staff, and Health Plan members, comprised a significant commitment of physician-time resources.

Four applicants for employment were found to have health problems which would seriously impair their ability to perform the jobs for which they had applied. This was less than .5 percent of the number examined. Eight applicants were hired despite health problems which, although important, would not interfere with job performance.

Including retired employees, there were 33 deaths recorded during 1974-75. Heart disease (14) and cancer (8) once again accounted for the large majority.

Dental Service

There were 9,566 visits to the dental service during 1974-75. Initially, care was limited to students and their spouses, but this year subscribers of the Health Plan and their dependents over age 14 have been accepted for care. When Dr. Owen W. Kite began the service, he hoped to make use of dental assistants to rationalize dental care by relieving the dentist of routine dental therapy. Unfortunately, the dental society has seen this as a threat and has forbidden such use of ancillary personnel. This is a great disappointment as it was hoped that by using dental assistants we could offer excellent dental care at less than cost to the patient.
Medical Department

**Psychiatric Service**

Data on the activity of the Service are given in Table I. Much of the following information was provided by Dr. Merton J. Kahne, Psychiatrist-in-Chief.

A pall of uncertainty hangs over the Institute. The continuing impact of economic stringencies within academic circles and the clouded outlook for jobs for students and faculty, together with national indirection in all spheres of social life, combine to restrain -- if not mute -- the energy and optimism usually so characteristic of the campus community. Students, ordinarily so attuned to social and political imperatives of our times, seem to find it difficult to mobilize their interests beyond preoccupation with personal and career direction, while faculty and administrators ponder strategies for fiscal stability. And for all personnel, questions of job security and inflated costs of living are ever present concerns.

There has been a continued and progressively increasing demand on the Psychiatric Service for family and couple counseling. In part this reflects a changing constituency -- the M.I.T. Health Plan is now more firmly centered within the totality of our activities than ever before. In part, it reflects the interpersonal strains increasingly a part of the lives of young professionals as they attempt to work out, and live with, the rapidly changing social roles of men and women as they adapt to contemporary life. In part, it seems to reflect an increasing tendency for individuals to solve their contradictory aspirations through attempts to remake their interpersonal relations rather than through modifying those aspirations when they strain existing interpersonal relations.

There also has been a progressive increase in the amount of care required by the individuals served, and a slow but sure widening out of the various groups who use our service. The relative proportion of students is dropping slowly. There is an increasing need for parent counseling and a steady demand for child evaluation and child therapy. This also reflects the shift in clientele resulting from the developing Health Plan. In the clinical area, we have begun to address the problems associated with the need for more systematic involvement in the planning and care of patients undergoing major surgery, particularly those surgical procedures which result in important alteration of body image or self-concept.

Progress in developing self-help groups among the international students and among student wives continues. In 1973-74 a substantial number of students who became familiar with our efforts on their behalf volunteered to help shape this year's program; an open house helped launch a successful year. We have noted with gratification not only an increased participation in the Wives' Discussion Group, but that many of the members have moved on to fuller involvement in the M.I.T. community. This year the Wives' group caught the interest of Carol Hulsizer who joined as a discussion leader. Ms. Hulsizer and her husband, Professor Robert Hulsizer, are the Faculty Family-in-Residence in Ashdown House. A number of projects were initiated -- some successful, some not. Noteworthy successes were an Independent Activities Period (I.A.P.) seminar on Child Development, planned and moderated by group members; and a baby-sitting service. "Wives' Notebook," an informational guide for newcomers to the M.I.T. community is nearing completion.

But the attempt to develop self-sustaining, socially useful, mutually supporting groups has not been without its difficulties. An important fact is that the leadership style cultivated and successfully exploited in the research-academic arena places a high premium on individual initiative, personal direction, and self expression. Valuable as such qualities are, they tend to undercut ventures that require collaborative exchange, group consensus, long range planning, and training for program continuity. Both students and spouses, seeing their situation as temporary, find it hard to take the long view and act on it. On the other hand,
programs organized and sustained by professionals and more permanent community members are antithetical to the main objectives of the program. Some effective mixture of innovation and tradition will have to be worked out.

This year also saw the reinstitution of a program of direct services to members of the Lincoln Laboratory community. On initiatives pursued by Dr. Peter B. Jenney, Associate Psychiatrist-in-Chief, with the collaboration of Lincoln Laboratory staff, we now again have a staff member at the Lincoln Laboratory for a half-day each week to provide directly the full clinical and nonclinical services which we have traditionally made available on the main campus.

As the academic year drew to a close, Dr. Alfred J. Koumans completed the first phase of complex planning for an Institute-wide employee assistance and alcoholism program. Patient negotiation with the many constituencies involved has been rewarded with a coherent, service-centered program which has received wide support. Hopefully, funds to permit implementation of this promising new activity will be forthcoming. We expect that the program will be administered through the collaborative efforts of Social Work Service, Psychiatric Service, and the Internal Medicine Service backed by an active committee, representative of the constituencies on the M.I.T. campus.

TABLE I

<table>
<thead>
<tr>
<th>PSYCHIATRIC SERVICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 1, 1974 - May 31, 1975</td>
</tr>
</tbody>
</table>

A) Total Individuals Seen 1243 (HP 229)
B) Total Number of Visits 4433 (HP 920)
C) Analysis of Caseload:

<table>
<thead>
<tr>
<th>Undergraduates</th>
<th>No. of Individuals Seen</th>
<th>Size of Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>59</td>
<td>1041</td>
</tr>
<tr>
<td>Sophomore</td>
<td>77</td>
<td>980</td>
</tr>
<tr>
<td>Junior</td>
<td>88</td>
<td>1056</td>
</tr>
<tr>
<td>Senior</td>
<td>100</td>
<td>1059</td>
</tr>
<tr>
<td>Special</td>
<td>7</td>
<td>446</td>
</tr>
<tr>
<td>Graduates</td>
<td>203</td>
<td>3468</td>
</tr>
<tr>
<td>Post-doctoral</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Faculty</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>Staff</td>
<td>147</td>
<td></td>
</tr>
<tr>
<td>Employees</td>
<td>179</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>Spouses</td>
<td>148</td>
<td></td>
</tr>
<tr>
<td>Dependents</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Alumni</td>
<td>83</td>
<td></td>
</tr>
</tbody>
</table>

410
D) Number of Individuals Hospitalized: 2  22 (HP 4)

Number of Individuals Referred to Clinics 67 (HP 22)
Private Facilities 104 (HP 43)3

E) Number of Individuals Hospitalized in Infirmary: 39 (HP 8)
Number of Days of Occupancy at Infirmary: 492 (HP 121)

F) Group Therapy: Twenty-one individuals participated in weekly group sessions throughout the year.

1 Excluding group therapy
2 At hospitals other than M.I.T. Infirmary
3 Includes approvals for treatment under the M.I.T. Health Plan

Social Work Service

Data on the activity of the Service are presented in Table II. The following information was provided by Jacqueline A. Buck, Chief Social Worker.

During the past year, there have been 1,626 visits to the Social Work Service. A total of 279 people used the Service for the first time. A small, but increasing number of Health Plan families utilized the Service during 1974-75.

In the past, we attempted to strike an appropriate time balance between meeting the demand for direct case work services to clients confronted by problems in their daily lives and in the lives of their families, and maintaining meaningful activity in other areas relevant to the broader Institute community. In addition to our liaison with M.I.T. and outside community agents, there were many other ongoing activities and projects in which we participated. Myra A. Rodrigues served as a member of the planning committee for the proposed Institute employee assistance and alcoholism program. Together with Charlotte Schwartz, sociologist, Mrs. Rodrigues spent many hours working with foreign students and their wives. Mrs. Rodrigues was also a member of two steering committees, one of minority faculty, students, and staff from the Office of the Dean for Student Affairs; and the other, a broadly representative group concerned with minority affairs at the Institute. Mrs. Rodrigues and a small group of black colleagues created and launched an outstanding I.A.P. seminar on "Black Perspectives." The turnout of minority and other students and staff exceeded all expectations, and it was clear that such an offering should continue as a permanent resource for minority students and a vehicle for consciousness-raising of black concerns in our community. In addition, Mrs. Rodrigues gave unstintingly of her time to lend support and participation in a myriad of extra-curricular activities planned by and involving minority students. She and certain other black staff and faculty added immeasurably, by the gift of their relationships, to the well-being and comfort of minority members of the Institute.

We participated in an urgently needed structural evaluation of the Technology Children's Center which serves a large number of M.I.T. families; the committee concerned with the handicapped; and also several special departmental committees, including the hospital-infirmary relations committee and the psychiatric planning committee.
Each year we pay special attention to a number of troubled pregnancies, terminal illnesses, chronic and traumatic illness, and situations of severe loss. We continued to be concerned with the welfare of handicapped students. Unfortunately, in 1974-75, there was the need to give support to some Institute families who were victimized by acts of violence. The stress of the current economic situation exacerbated the problems of many of the people we saw this year.

### TABLE II

**SOCIAL WORK SERVICE**

June 1, 1974 - May 31, 1975

<table>
<thead>
<tr>
<th>Total Cases: 766</th>
<th>New Cases per Category: 279</th>
<th>Total Visits: 1,626</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>15</td>
<td>120</td>
</tr>
<tr>
<td>Staff</td>
<td>23</td>
<td>88</td>
</tr>
<tr>
<td>Student:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>16</td>
<td>92</td>
</tr>
<tr>
<td>Graduate</td>
<td>13</td>
<td>78</td>
</tr>
<tr>
<td>Student Spouse:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>Graduate</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>Foreign Student:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Graduate</td>
<td>31</td>
<td>100</td>
</tr>
<tr>
<td>Foreign Student Spouse:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Graduate</td>
<td>40</td>
<td>499</td>
</tr>
<tr>
<td>Employee</td>
<td>69</td>
<td>347</td>
</tr>
<tr>
<td>Other</td>
<td>37</td>
<td>123</td>
</tr>
<tr>
<td>CRC</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>HP</td>
<td>25</td>
<td>127</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td>279</td>
<td>1,626</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>New Referrals:</th>
<th>Total Referrals:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical</td>
<td>42</td>
</tr>
<tr>
<td>Psychiatry</td>
<td>30</td>
</tr>
<tr>
<td>Self</td>
<td>86</td>
</tr>
<tr>
<td>Other Departments</td>
<td>116</td>
</tr>
<tr>
<td>Personnel</td>
<td>5</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td>279</td>
</tr>
</tbody>
</table>
The Infirmary statistics are given in Table III. Occupancy of the Infirmary was about the same as it has been for several years. Health Plan members accounted for 70 admissions (13.6 percent) and 590 patient days. The most common diagnoses among the admissions were respiratory diseases (131), acute gastroenteritis (48), infectious mononucleosis (36), and depression (25). Sixty-two of the admissions were patients transferred from a general hospital, usually the Mount Auburn Hospital, for post-operative care.

The observation unit has functioned well during the year with 421 patients, one-quarter of whom were finally admitted to the Infirmary. This unit is analogous to the "overnight ward" of some major hospitals and functions as a holding unit to clarify the status of the patients who may not be ill enough to be admitted to the Infirmary directly.

No major surgery is performed at the Infirmary, but there were 603 minor surgical procedures during the year, an increase of 33 percent over the previous year. The majority of these operations were the removal of skin lesions and the suture of lacerations. The number of athletic injuries (577) was about the same as last year.

TABLE III
M.I.T. INFIRMARY
June 1, 1974 - May 31, 1975

| Number of Patients Admitted to Infirmary: | 515 |
| Number of Patients Remaining from May, 1974 | 3 |
| TOTAL | 518 |
| Number of Patients Discharged | 493 |
| Number of Patients Transferred | 21 |
| Patients Remaining after May 31, 1975 | 4 |
| TOTAL | 518 |

ADMISSIONS

<table>
<thead>
<tr>
<th>Number of Patients</th>
<th>Days in Infirmary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>Faculty 156</td>
</tr>
<tr>
<td>Staff</td>
<td>Staff 229</td>
</tr>
<tr>
<td>Employees</td>
<td>Employees 804</td>
</tr>
<tr>
<td>Graduate Students</td>
<td>Graduate Students 331</td>
</tr>
<tr>
<td>Students</td>
<td>Students 857</td>
</tr>
<tr>
<td>Student Spouses</td>
<td>Student Spouses 147</td>
</tr>
<tr>
<td>Other</td>
<td>Other 254</td>
</tr>
<tr>
<td>TOTAL</td>
<td>TOTAL 2,778</td>
</tr>
</tbody>
</table>

413
Vice President

Medical  303
Surgical  180
Psychiatric  32
TOTAL  515

Clinical Laboratory, Electrocardiogram, X-ray

Although there was about a 12 percent decrease in the number of chest X rays taken during the year, there was a 9 percent increase in other X-ray work. The total number of X rays taken was 9,682. Our X-ray equipment is excellent, but our filing space is inadequate.

The number of electrocardiograms taken was 2,690, an increase of 10 percent over the year before and twice as many as five years ago. The capacity of the ECG Department to take electrocardiograms is being strained severely because of space limitations.

There was a 21 percent increase in the number of laboratory tests performed during the year, with a total of 59,222 of which 13,121 were done at the Mount Auburn Hospital. The extremely cramped laboratory space in Building 11 not only presented difficult and unpleasant working conditions for the technicians, but also drew criticism from the state inspector. We are currently expanding the laboratory to meet minimum requirements, but even by sacrificing a badly needed medical office we will not have the space to provide really adequate laboratory facilities.

Sanitation

Routine bacteriological monitoring of the M.I.T. food services and the swimming pool continues to be handled by the Massachusetts Dairy Laboratories. Fred E. Smith, our consultant Sanitary Engineer, reviews the bacteriological results and inspects the facilities regularly. There were no major problems during 1974-75.

M.I.T. Health Plan

The following information was provided by Laurence H. Bishoff, Associate Director for Administration.

During 1974-75, enrollment in the M.I.T. Health Plan rose from 2,700 to 3,600 members. At the beginning of the year, enrollment in the pilot plan increased due to the conclusion of arrangements with the Charles Stark Draper Laboratory, Inc. to offer the Plan to Laboratory employees.

By spring of 1975, 300 employees and their families who were on the waiting list for the Plan were invited to join. The invitation marked the end of the period of limited enrollment and the adoption of the Plan as a permanent program of the Medical Department. Approval
of the Plan followed an evaluation process which had been scheduled to take place after three years of pilot scale operation. Acceleration of the evaluation was occasioned by the passage of the Health Maintenance Act of 1973.

From the evaluation it was concluded that the Plan’s operation in the first year resulted in a significant reduction in projected hospital utilization for the enrolled population, while offering increased ambulatory benefits. (Hospital utilization was 390 days per 1,000 members per year while the Infirmary occupancy totaled 120 days per year on an adjusted basis.) Consumer satisfaction, measured in more than one way, appeared to be high. Moreover, there were a few dramatic examples of how low barrier access to medical care led to early diagnosis and treatment of serious illness.

Validation and approval by the Executive Committee of the M.I.T. Corporation was followed by planning activity to increase enrollment to 8,000 members within the next three years. Current enrollment is limited by the Department’s limited out-patient space, and plans were undertaken to expand the available area to accommodate this larger group.

At the same time, we recognized that a long term solution for the Department’s space problems must be found. New space must be constructed to accommodate long term growth and replace inefficient and obsolete facilities which do not meet present minimum standards or requirements of regulatory agencies.

During this second year of operation, members visited the Department an average of 5.6 times during the year. Hospital utilization was high: an average of 454 hospital days and 229 Infirmary days per 1,000 members. Hospital utilization included an artificially high number of obstetrical admissions because the Plan’s maternity benefits offered to M.I.T. employees are broader than the standard Blue Cross offering. Approximately 30 additional hospital days were due to this high maternity rate. Total hospital days and length of stay were also unusually high due to four admissions which accounted for 20 percent of the hospital days. All admissions, except these four, averaged 5.1 days length of stay. The four admissions each averaged 66 days length of stay and increased the overall average length of stay from 5.1 to 6.2 days in the hospital. These admissions were responsible for 91 of the 454 days per 1,000 members. The cases involved highly unusual and major procedures, and as a result, a catastrophic illness reserve has been established. Even with these cases, however, the Plan operated within its projected budget.

Membership turnover continued low, indicating continued satisfaction with the Plan. There were 132 terminations during the year as employees left M.I.T. or the Draper Laboratory. An additional 54 employees converted back to Master Medical: 20 wished to retain outside physicians, 33 converted because of reasons related to their employment status or benefit status, and one employee was dissatisfied with the medical care given.

Radioactivity Center

This is the first time the Radioactivity Center has been included in the Medical Department annual report. The following brief review of the nature of the studies performed and the activities during the year was provided by Dr. Melvin H. Chalfen, Director of the Center.

Some 50 years ago, several thousand people were inadvertently exposed to radium and mesothorium when they worked as radium dial painters and radium chemists, or when they were treated with radium- and mesothorium-containing preparations. These people, plus
several hundred more who since then have had small exposures to these and other alpha emitters, are the only group of people in the world available for such studies. Professor Robley D. Evans of the Department of Physics was involved in studies of these people for several decades, and created the Radioactivity Center at M.I.T. Upon his retirement, the Center became a part of the Medical Department.

The purpose of the investigation is to study the effects of the bone seeking alpha emitters, primarily radium and mesothorium, upon the human body. The investigations center around the correlation of medical effects as determined by medical history and physical examinations, skeletal X rays, clinical blood and urine studies, and the body burden of radioactivity as determined by the physicists with breath radon and thoron tests, bone densitometry, and whole body counting. The results of these studies are used to aid in the determination of maximal permissible standards of exposure to internal emitters such as strontium and plutonium, substances of extreme importance to the increasing number of workers in nuclear energy fields such as the nuclear power industry.

The Center maintains laboratories including a whole body counter, breath radon collecting and analysis equipment, bone densitometer apparatus, and other related instruments. The staff includes Professor Evans as consultant, C. J. Maletskos as consulting physicist, a senior staff supervisor, two experienced technicians, and a laboratory technician. The three-person office staff includes personnel experienced in contacting and tracing patients and working with them.

From July 1, 1973 through June 30, 1974, there were 87 patients studied at M.I.T., 35 of whom stayed and were studied at the Clinical Research Center where more detailed metabolic studies are done. From July 1, 1974 through June 30, 1975, there were 67 patients at M.I.T., 34 of whom stayed at the Clinical Research Center. There were fewer patients this year because of changes in personnel and illness in our laboratory staff.

The Radioactivity Center operates as a part of the Center for Human Radiobiology of the Argonne National Laboratory, and is funded through the United States Energy Research and Development Administration.

Environmental Medical Service

The following information was provided by Dr. Franklin D. Aldrich, Samuel Levin of the Radiation Protection Office, and Richard Chamberlin of the Industrial Hygiene Office.

The 1974-75 period was, in many ways, a "holding action" for the Environmental Medical Service (E.M.S.). Spiraling costs and the pressures of increased demands for E.M.S. services combined to limit expansion of much needed services, particularly in the fields of non-ionizing radiation protection, monitoring of X-ray machines, and particle accelerator safety (except at the Bates Linear Accelerator).

The continuing program for monitoring the health status of M.I.T. personnel who work with chemical carcinogens revealed no evidence of abnormalities in a group of 53 persons deemed to be at risk. This testing program was begun in 1972 with a group of 12 persons; the increase in their number reflects expansion of carcinogenesis research at the Institute.

Opthalmologic examination of 125 individuals at Lincoln Laboratory and 45 main campus personnel who work with lasers revealed no evidence of laser-induced eye injury in the present year.
Radiation Protection Office

The Radiation Protection Office (R. P. O.) carried out its mandated functions and, in addition, supervised the modifications to the M.I.T. Reactor. This project included dismantling of the MITR-I reactor core and assembly of a new core for MITR-II. Although high levels of radiation were observed during this operation, excessive radiation exposure to personnel was obviated. Table IV summarizes R. P. O. activities in the present year and in the prior reporting period.

Expansion of Institute research programs and imposition of new Federal regulations increased R. P. O. services. The number of laboratories on campus which house or otherwise use radioisotopes increased from 270 in 1973-74 to 310 in 1974-75. Accordingly, radiation surveys in all laboratories have increased from 4,040 to 4,850 over the same period. In spring, 1974, a new committee was formed to satisfy Federal requirements governing licensees who would administer radioisotopes to experimental subjects. The Committee on Radiation Exposure to Human Subjects (CORETHS) held five meetings during 1974-75 and considered all current authorizations within its purview.

At the Bates Linear Accelerator (LINAC), increased beam-on-time has necessitated 24-hour coverage by R. P. O. personnel. Approximately 2,000 hours of beam-on operational time were logged during this reporting period, divided into 72- and 96-hour runs. During the next year, a 50 percent to 75 percent increase in beam-on-time is anticipated.

| TABLE IV |
| RADIATION PROTECTION OFFICE |
| June 1, 1974 - May 31, 1975 |

| 1. Number of currently registered radiation workers | 1,370** | 1,310** |
| 2. Number of workers currently issued film badges or TLD's | 550** | 740** |
| 3. Number of radioisotope laboratories | 270 | 310 |
| 4. Number of radioisotope surveys: |
| a. Routine surveys | 4,040 | 4,850 |
| b. Special surveys | 230 | 190 |
| 5. Authorization for use of radioisotopes: |
| a. Number of current approved authorizations | 210** | 190** |
| b. Number of reviews of authorizations and amendment-requests | 80** | 80** |
| 6. Sample analyses in R. P. O. Counting Room in Bldg. 20: |
| a. Number of persons measured with in-vivo counting system | 100 | 180 |
| b. Air sample analyzed | 2,340 | 3,680 |
| c. Wipe-test samples analyzed | 13,320 | 13,440 |
| d. Samples counted by liquid scintillation counter system other than wipe-tests | - | 2,390 |
| 7. Use of Room 6-017 by Institute departments in man-hours | 880 | 920 |
8. Radioactive Waste Program:
   a. Gallons of liquid waste processed 1,230 1,010
   b. Containers of compactable solid waste processed - 1,150
   c. Containers of non-compactable solid waste processed - 160
   d. Volume in cubic feet of solid waste shipped to burial site 2,000** 2,670**
   e. Total solid waste activity shipped in millicuries 3,700** 35,800**

* Numbers are rounded off to nearest 10
** Totals for On-campus, Reactor, Lincoln Laboratory and Bates Accelerator

Industrial Hygiene Office

Industrial Hygiene Office (I.H.O.) programs continued in 1974-75 essentially as in previous years, with moderate increase in demand for services brought about by new campus construction (Chemical Engineering building) and expansion of existing programs. Of note is the accreditation of the I.H.O. laboratory by the American Industrial Hygiene Association on the basis of proficiency in chemical analyses. Only 35 such accreditations have been granted in the United States.

Veterinary Service

The animal care issue is a critical one as there has been a dramatic increase in the use of experimental animals at M.I.T. This year, more than 30,000 animals were purchased whereas ten years ago, the number was 5,000. This growth was not anticipated, and, as a consequence, a scattering of animal facilities have appeared on campus, most of which are unsatisfactory. In 1973, the Medical Department was asked to assume the responsibility for the Veterinary Service, and it became part of the Environmental Medical Service. Under the leadership of Dr. Melvin H. Rodman, chairman of the Animal Care Committee, Dr. Franklin D. Aldrich, Environmental Medical Service, and Dr. Kenneth Goddard, Institute Veterinarian, planning began in conjunction with the Planning Office for a central animal facility which also would include special laboratories for high hazard research projects. Upon Dr. Goddard's resignation to enter private practice, a search committee headed by Dr. Aldrich interviewed many specialists in laboratory animal medicine. The committee was fortunate to find Dr. James G. Fox who joined us in July, 1974. Beginning July 1, 1975, Dr. Fox will be director of the new Division of Laboratory Animal Medicine in the Medical Department and also will become Associate Professor of Laboratory Animal Medicine. The following information was provided by Dr. Fox.

The Institute is faced with a perplexing dilemma. Federal governmental agencies are urging M.I.T. faculty and research staff to explore new areas in biomedical research; at the same time they are establishing increasingly stringent requirements for animal facilities; and, finally, these agencies have not established funding mechanisms by which the Institute reasonably can finance the extensive associated costs of renovations and new construction.

Since the early 1960s, the Institute's research efforts in the biological sciences have been increasing at a rapid rate. These changes are evidenced by the expanding utilization of animal models in the Departments of Biology and Nutrition and Food Science, the creation of a Department of Psychology with heavy emphasis on behavioral research, and the recently completed Cancer Research Center of which animals occupy one entire floor. The burgeoning field of bioengineering also often results in the use of animals to combine effectively the biomedical sciences with engineering principles.
Concurrent with these new directions in research, there has been a substantial growth at the Institute in the use of experimental animals. Presently the Institute houses, on a daily basis, 10,000 animals of various species. In the next five years, the number of animals housed daily is expected to reach approximately 15,000. For fiscal 1975, funds for biomedical research totaled about $20,000,000; of that total, $12,000,000 was in departments which conduct animal related research.

Physical facilities and operational programs have not been expanded sufficiently to accommodate the increased use of laboratory animals for experimental research. A high number of satellite animal units have evolved over a ten-year period as the Institute has responded to the increased need for animal space. Unfortunately, in many respects this has been a piecemeal, crisis-oriented approach.

Federal control of the conduct of research involving use of animals continues to expand. The Laboratory Animal Welfare Act of August, 1966, and the Animal Welfare Act of December, 1970, outline the legal requirements for the proper care and humane treatment of laboratory animals. The 1966 Act did not have a serious impact on M.I.T. and other research facilities because it was directed to protect animals during the conditioning and holding phase, not animals used during the experimental process. However, the 1970 Act included strict supervision of animals utilized during experiments. Coupled with the legal stipulations set forth in the Welfare Act, is the policy issued by NIH in 1971, which states that institutions using laboratory animals in projects funded by NIH shall assure the NIH that the institutions will evaluate their animal facilities in regard to maintenance of acceptable standards for the care, use, and treatment of such animals. This assurance is provided by a recognized professional laboratory animal accrediting association reviewing each institution at regular intervals.

This NIH policy statement, however, as described by the head of NIH's Animal Resource Branch (ARB), Dr. Charles MacPherson, and Dr. Marc Conner of the Division of Research Grants, had "no teeth" for implementation of the policy. Therefore, under a directive from the highest levels of the Department of Health, Education and Welfare (HEW), a new policy to be issued shortly will supersede the old NIH policy. Under the terms of the policy, institutions which fail "in a material manner to comply with the terms of this policy" will:

- with respect to an institution: determine that its eligibility to receive further HEW grants involving animals be withdrawn.
- with respect to a particular HEW grant or contract utilizing animals: determine that the grant be terminated.
- with respect to an individual investigator employed by the grantee or institution: determine that he or she is no longer qualified to serve as principal investigator under grants involving the use of animals.

In 1972, the Institute was given provisional accreditation by the American Association for Accreditation of Laboratory Animal Care (AAALAC), with stipulations that certain physical facilities at the Institute would be upgraded. In 1972, full accreditation was given, but with additional provisions that Institute-wide upgrading of animal facilities would be undertaken. Since that visit, work to renovate facilities has not been sufficient to meet accreditation standards. A site visit by an AAALAC committee, in March, 1975, offers the prospect that the Institute will be placed on probation or will lose accreditation status. Loss of AAALAC accreditation could mean that NIH approval and funding of major research projects will be withdrawn or curtailed.
Vice President

Congressional action on impending legislation regulating animal usage in biomedical research is expected to lead to even more stringent regulations. These amendments to the Animal Welfare Act, if passed, will further increase our need for additional animal space and upgrading of existing facilities. The mood of Congress is reflected in the new NSF funding requirements which, if upheld, would seriously handicap the foundation's efforts to fund research projects. Local and national societies regarding humane treatment of animals are constantly lobbying in Congress. A number of bills in the last Congressional session were introduced to prohibit the use of dogs in research, thus indicating the substantial influence exerted by these lobbying groups.

In another arena of governmental control, the U.S. Department of Labor, in February, 1974, under the auspices of the Occupational Safety and Health Act (OSHA), issued regulations governing the use of certain carcinogenic chemicals. Of the 14 compounds currently on the list (which will probably increase), ten were identified in use as integral parts of carcinogenesis research involving animals. This further adds to the need to upgrade physical facilities for animal research to satisfy the OSHA regulatory arm of the government.

Federal Funding Deficiencies and Alternative Institute Funding: The Federal government has responded financially in a limited way in assisting research institutions in complying with the ever increasing animal welfare regulations. Aid via the Animal Resource Branch of the NIH has been through grants awarded to upgrade animal facilities. From 1962-1970, about 10 such grants a year totaling $500,000 per annum were awarded to various institutions. With the passage of the Welfare Act of 1970, the ARB has in 1974, awarded approximately 23 projects totaling $2.2 million. These grants are usually for one year, in essence a one shot attempt to bring facilities into compliance. The grant awarded to M.I.T. in 1975 for $150,000 is the maximum allowed: $75,000 for renovations, $75,000 for equipment. This figure is approximately five percent of the $3.5 million needed for campus-wide renovations. No new construction funds are available through the NIH Animal Resources Branch. Sponsoring agencies still require that universities have the necessary facilities to perform animal related research if they are requesting animal related research grants or contracts. These agencies also feel that a part of the overhead costs, which are charged under research grants, should be used for funding of renovations and construction of these facilities.

At this time the Institute has not received gift capital for these purposes nor is it prepared to cut back on animal-related research. The cost, therefore, of upgrading the satellite animal care units and the construction of a centralized animal care/special hazards facility, must be shouldered by the Institute. Because of the urgent need for progress in this area, staff members of E.M.S., the Planning Office, and Physical Plant have developed renovation programs for the various facilities. In conjunction with renovation of the facilities, a temporary building must be constructed to house the animals displaced during the renovation period. The costs for renovations and construction of the temporary "decant" facility at $150 per net square foot is estimated at $3.5 million.

Several funding alternatives for renovation and new construction costs for animal facilities have been reviewed:

1) A direct "per animal" charge approach to users of space to be renovated appears untenable because the costs involved would place an exorbitant 'per-head' charge on each animal.

2) Since current government procedures do not provide for reimbursement of interest costs on borrowed capital, a third-party ownership of animal facilities
Medical Department

has been considered. Under this scheme, reimbursement of M.I.T.'s rental costs might be possible. The site would have to be in close proximity to M.I.T. laboratories where the actual research is conducted. This scheme would require lengthy legal manipulations to set up a third-party corporate entity.

3) An M.I.T.-Harvard animal care consortium has been discussed with Henry Meadows, Senior Associate Dean for Administration at Harvard and Dr. Bernard Trum, Director, Animal Care Facilities at Harvard. Although this scheme has some potential, further discussion must await resolution of the animal care issue at Harvard. Dr. Trum is retiring and a new director has not been appointed.

4) The direct reimbursement by the National Cancer Institute (NCI) of 75 percent of costs of renovation or that fraction of new animal facility construction that is directly related to cancer research is an attractive funding scheme. Approximately 60 percent of the animals at the Institute are utilized in cancer research.

Currently the Institute's plan as adopted by the Committee of Research and Space Planning is to phase the renovation program and minimize demand on general Institute funds and on overhead recovery in a single fiscal year. The phased expenditures for renovation are hopefully to be recovered via the sponsored research space/leasehold improvement method. A recovery rate of at least 90 percent over five years is feasible since at least 95 percent of this space is used exclusively for research. However, the space change route has a high impact on recovery rate; e.g., about 2 points in fiscal year 1978. The Office of Sponsored Programs intends to explore the possibility of NCI funding and other funding to compare the attractiveness of funding via space change recovery or other forms of reimbursement.

Central Institute Facilities: There is a current lack of proper veterinary diagnostic and clinical laboratories, plus a severe shortage of strict quarantine facilities. In 1970, an epidemic of tuberculosis in the non-human primates housed in the Department of Psychology was disastrous to the Department's research efforts, and equally as important, created a serious health hazard to those personnel working with the animals. During 1974-75, about 70 different clinical diseases were documented in the 12 species of laboratory animals housed at the Institute. No fewer than 20 of these are zoonotic diseases, i.e., animal diseases that also may infect man.

In many instances, such diseases, in man, may cause severe illness. The physical limitations of the animal facilities and lack of proper diagnostic support make it difficult to control, treat, and prevent the spread of these diseases to other animals, and indeed, to man as well. The increasing use of carcinogenic material in animal related research adds another potential danger to human health and further adds to the need for updating existing facilities.

The construction of a Central Animal and Special Environmental Facility must be undertaken if the Institute is to respond in a positive manner to the increasing Federal regulations and standards applied to the procurement, care, and management of animals and the increasing knowledge concerning the handling of hazardous materials. The centralized facility would provide a location where animals could be received, examined, quarantined in a controlled environment for a specified interval, and then distributed to the satellite animal facilities. In addition, laboratories for diagnosis, isolation, surgery, and treatment of ill animals would be provided. This facility also would have a series of
multipurpose laboratories for use with animals and exceptionally hazardous material. The total projected cost for the facility of 23,000 net assignable square feet is estimated to cost $5.2 million. Discussions are currently under way to decide the most feasible fiscal approach to finance the central animal facility and special hazards unit.

Though the Institute is genuinely concerned at the large sum of money that will be needed to upgrade existing facilities and construct a new central animal facility, most investigators will agree that the humane care and handling of animals, particularly where it applies to elimination of stress and disease in research animals, are mandatory when scientifically valid research is required.

JAMES G. FOX

Arteriosclerosis Center

The following information was provided by Dr. Robert S. Lees, Director of the Arteriosclerosis Center. The M.I.T. Arteriosclerosis Center had a busy and productive year. The Center operated in conjunction with the Noninvasive Diagnostic Laboratory of the Massachusetts General Hospital (MGH) as an interdepartmental interinstitutional clinical research facility. The past year has seen the fruition, as clinically useful diagnostic or therapeutic methods, of several projects which began as pure laboratory research—the kind of progress from research laboratory to the care of the sick which was the goal of the Institute and the Hospital in founding the Center.

The success of phonoangiography is perhaps the most clearcut example of progress from laboratory to clinic. This method of sound analysis has been shown to allow noninvasive diagnosis of arteriosclerotic narrowing of the major blood vessels in the neck which supply the brain. Applicable to most patients in whose narrowed arteries blood makes a noise (bruit) as it rushes past the narrowed area, the method requires only that a microphone be placed on the skin over the point of maximal intensity of the bruit. The taped sound is analyzed by a minicomputer system devised and built by Professor C. Forbes Dewey, Jr. of the Center and the Department of Mechanical Engineering and Richard Metzinger of the Charles Stark Draper Laboratory. The clinical trial of the method, which now has been used in almost a hundred patients, was performed at the MGH by James O. Gruber, a graduate student of the Center and the Department of Mechanical Engineering, in collaboration with Dr. Lees, Professor Dewey, and Dr. Gordon S. Myers. The investigators feel that the method, whose development spans a period of more than five years, may make it possible to screen patients for stenosis of the carotid arteries in the neck with reasonable accuracy and no pain or risk.

Other achievements of the Center within the past year included the demonstration that patients with high blood cholesterol have abnormally high sensitivity of the blood platelets and that this phenomenon may help explain why people with high cholesterol are much more susceptible to heart attacks, strokes, and other complications of blood clotting within narrowed blood vessels. The investigators, who include Drs. Angelina Carvalho and Robert W. Colman, both of the Center and the MGH, as well as Dr. Lees, also have shown that this tendency to block blood vessels can be modified by appropriate drug treatment. Treatment by a special technique which can only be performed in a hospital can lower the cholesterol in severely affected patients who may have blood cholesterol concentrations three to five times normal. The method, called intravenous hyperalimentation, actually allows cholesterol in the form of cholesterol-bearing protein to leave the blood at a more
rapid rate, as shown by Dr. Harold Torsvik, formerly of the Center and now at the University Hospital of Oslo, Norway. These findings will lead to better ways of treating hypercholesterolemia and combating both the arteriosclerosis and abnormal coagulation which result from it.

Ongoing projects at the Center include studies of the basic process by which arteriosclerosis begins, namely, injury to the arterial wall and disruption of the normal mechanism of repair; noninvasive detection of clotting in narrowed vessels before they block completely and produce strokes or heart attack; and understanding the role that turbulent blood flow plays in the production of arteriosclerotic lesions and the role that audible sound and ultrasound can play in detection of the disease.

ALBERT O. SEELEER
Vice President, Administration and Personnel

This has been a busy year. The fall term began with a strike of the building service and dining service employees. The spring term saw the beginning of intensive effort by the members of the Working Group on Office-Clerical Issues to resolve problems highlighted in a study of those issues begun the previous summer. The Staff Classification and Salary Administration Program was completed only at the year's end, after a full 18 months of work. The Task Oriented Budget review of programs and costs for fiscal year 1976 captured a good deal of attention from November, 1974 onward. A working draft of Policies and Procedures, the guide for faculty and staff members, was published in April, 1975, as the penultimate phase of a process of revision begun some years earlier, with final review, revision, and publication expected in July, 1975.

The reports which follow describe and assess in more detail the work of the offices and the activities for which I am accountable. They are the Admissions Office; the Student Financial Aid Office; the Career Planning and Placement Office; the Planning Office; the Academic Staff Records Office; the three offices which together make up the M.I.T. Personnel Office: Personnel Development, Personnel Relations, and Personnel Services; the Child Care Program; the Building 7 Lobby program; and the Affirmative Action Program. As an introduction to their reports, I will single out what I see as some of the key issues and accomplishments of the year.

The Admissions Office was asked to achieve an enrollment of 1,130-1,150 in the Class of 1979, which would register in September, 1975. This is a class larger than the Class of 1978 by nearly 100, and 200 larger than the average class size in the preceding five or six years. The growth has been made possible by additional undergraduate housing and has been influenced by budgetary pressures. With final applications at 4,600, up slightly from 1974, the Admissions Office has been able to meet the established goal and, given the uncertainties of individual applicants' decisions to accept or decline offers of admission, may even exceed it.

While white male applications were up this year over 1974, applications from women and minorities were down -- a source of concern and stimulus to still greater effort to reach these groups with information about the advantages of an M.I.T. education.

A key influence on an applicant's decision is, inescapably, the size and composition of the financial aid offer, if financial aid has been requested. With the average undergraduate academic year budget rising by ten percent to $6,800 for 1975-76 and with little growth in designated scholarship funds available, the "self-help threshold" and the unrestricted funds supplement to the scholarship pool became a very important question. After an evaluation of the self-help levels of other universities with which we share significant numbers of applicants and an assessment of the costs in unrestricted funds of alternative self-help levels, we established the 1975-76 level at $2,100, $350 above the $1,750 level of the two previous years. This means that the student in need of financial aid must meet the first $2,100 of his or her need by a loan and/or job. The high percentage of acceptances of our offer of admission among financial aid applicants suggests that this was a sound choice for M.I.T. Other evidence suggests it will be a financially sound choice for the student as well, for the Career Planning and Placement Office reports, despite the recession, a strong demand for M.I.T. graduates, with more firms recruiting here than in any year since 1969-70.
M.I.T. as an employer was also quite active during the year, receiving applications from 3,600 people for nonacademic positions and hiring 600 of them primarily as replacements. Emphasis on affirmative action in employment continued strong. By year's end, 11 percent of the office and clerical employees were members of minority groups, with eight percent black. Hourly employees were 13 percent minority and 11 percent black. At the administrative staff level, minorities totaled six percent, of which four percent represent black staff members, and women made up 30 percent of the staff, up from 14 percent in 1970.

Administration of personnel matters for the academic staff (faculty members, lecturers, research associates, and others) in terms of recruitment, appointment, promotion, salary administration, leaves, and terminations is largely decentralized to the academic departments. However, the many thousands of separate transactions annually converge in the Academic Staff Records Office where the notices of appointment, promotion, and salary change are prepared, checked, and recorded. In all, more than 2,000 faculty and staff members records are handled in this office.

As an employer, M.I.T. seeks to increase the satisfactions and opportunities for work here. The system of posting all vacant nonacademic positions afforded opportunities for promotion or transfer on a scale well beyond that of the recent past, with about 180 employees successfully placed in new positions.

One force of consequence in this effort has been the Office of Personnel Development which completed its first full year under the leadership of its co-directors, Drs. Adam and Maureen Yagodka. They introduced and led skills-building workshops in communications, problem-solving, and decision-making for persons in all occupational groups across the Institute. The workshops generated a demand for similar sessions within a number of academic and administrative departments. The Human Processes Workshops, the Administrative Development Program, the growing use of tuition assistance for career-related study, and the plans to move into supervisory training in the coming year all exemplify the Institute's intention to emphasize opportunities for personal and career development and advancement now and in the years ahead.

The completion of the Staff Classification and Salary Program should contribute significantly to that goal. While its first purpose is to assure equity in salary administration, its effect is to describe explicitly the duties and entry qualifications of our administrative staff positions. And by publicly identifying all those positions for the first time and arranging them in levels for salary administration purposes, we are, in effect, drawing a career planning map of M.I.T. available to all who may aspire to a career here in administration.

While the Salary Administration Program has properly focused on the important component of the rewards of employment, we have continued to improve and extend the benefits portion of compensation and, perhaps as important, individual understanding of the nature and value of our benefits. For most classes of employees and staff, the face value of contributory group life insurance was increased to three times salary, and the Tax Deferred Annuity Plan was made available to all Institute personnel. Work was completed on a statement of benefits to be distributed to all faculty and staff during the summer, and the first of a series of reports covering the financial experience of the Retirement Plan for Staff Members was completed.

Another dimension of concern for the needs of those working at M.I.T. -- and of students, too -- is our Child Care Program. The active encouragement and support of family day care (care within the homes of M.I.T. people, principally, married graduate students) has been a major effort. We have continued to provide assistance and facilities to Technology Children's Center, Inc., which runs the Nursery School and the Day Care Center. The office of the child care coordinator also has been a central clearing house for information about day care services available in the area.
Vice President, Administration and Personnel

My concerns extend beyond admission, financial aid, and placement of students, and beyond recruitment, placement, and training of employees, to planning for the physical facilities for their work, study, and recreation. The M.I.T. Planning Office had an active year in developing building programs for a number of proposed new facilities, including a central animal care facility and major additions to our athletic plan, as well as being involved in the progress of facilities under construction, such as the new Chemical Engineering Building, the new undergraduate residence, and the Center for Cancer Research, which was completed during 1974-75.

The Planning Office has been very much concerned with local issues which may impact on the quality of the M.I.T. environment, including the Kendall Square renewal plans, and the parking and transportation edicts of the Environmental Protection Agency.

With the beginning of the M.I.T. Leadership Campaign, facts, concepts, designs, and proposals will all be required from the Planning Office to support those actively working on the Campaign.

As Suzanne Weinberg states in her report for the Lobby 7 Committee, "Building 7 Lobby continued to serve the M.I.T. community as a lively arts forum for groups from inside and outside the Institute." This has indeed been our goal. Lobby 7 has been a lively place serving variously as M.I.T.'s front door, its information center, a place to meet friends, to sit, watch, talk and listen, perform, exhibit, and to enjoy performances and exhibits. On matters of art, reasonable people can disagree -- and do. And the Lobby 7 programs have their critics, who were most severe over the Food Exhibit in the spring. We look forward next year to a high-quality Lobby 7 program with variations on the Bicentennial theme.

I said at the outset of this report that it had been a busy year. I had been tempted to say also that it had not been an easy year in the sense that there were many problems and few new initiatives. Yet as I have reflected on the work of the year -- and even on the problems -- it seems to me that they were inevitable in the cycle of fulfillment of earlier initiatives, that the dreams and plans of last year are the seeds of this year's challenges as we move from concept to completion.

To all those in my area of responsibility who contributed by hard and imaginative work to the fulfillment of our goals, I am deeply grateful on my own account and on behalf of the Institute. In a time of rising costs and shrinking budgets, all members of the administration are being asked to do more with less, and in my judgment have responded with characteristic M.I.T. loyalty and commitment to this challenge.

JOHN M. WYNNE

Office of Admissions

The admissions task is not unlike that of a farmer. We plan ahead, prepare the ground, work hard, very hard at certain times of the year, and then repeat the process next year. If we do this right and the fates are kind, the harvest is bountiful. But this does not always happen.

The number of undergraduate applications overall was up just a little over last year, but in spite of our efforts women and minority applications were down. For the minorities we have evidence to suggest that the pool of potentially qualified applicants is inadequate to fill the
openings available in the competitive colleges. While this is grounds for an increased effort to attract those qualified, it does have a dampening effect on our optimism about the future. For the women, the pool of applicants is there, although we have several years to go before the idea of women at M.I.T. becomes a part of the nation's conventional wisdom. In addition to the Admissions Office's efforts to encourage applications from individual high school seniors, the drive to provide M.I.T. with an image which includes women must continue at all levels.

Direct mail was employed again this year to contact 17,000 potential undergraduates, but visits to high schools were limited by budget considerations.

The decision to increase the class size raised the question of the depth of the applicant pool, but the quality of our applicants still leaves us in the position of refusing many talented young men and women. The selection is continuing to be made without regard to the sex of the applicant.

Just as the academic year was beginning, we became aware of the Federal legislation concerning student and parent privacy rights, the Buckley Amendment. What was (and is) conceived as an effort to protect the individual has the potential to create an administrative nightmare or, what is more serious, the loss of frank articulation between secondary schools and colleges concerning the student's strengths and weaknesses. It will take a year or two more of experience with this legislation before the full impact is understood.

The changes in high school curricula in the past several years have been in the direction of an increased effort to respond to the individual student's perceived emotional needs with less emphasis on the traditional course content. As a result, the evidences of potential may be obscured and the preparation for the beginning subjects at M.I.T. more varied. Those who must choose among talented students, as M.I.T.'s admissions process requires, are faced with this less obvious pattern, just when the variety of freshman programs at M.I.T. and pass/fail make the criteria for defining success more elusive. The Committee on Undergraduate Admissions and Financial Aid began a review in 1974-75 of the academic predictors of success at M.I.T. Faculty participation in the review process continues to make a significant contribution both to the immediate task and to the staff's understanding of the faculty's views of the student body.

The number of college transfer applicants remains stable, with most of the successful candidates coming from four-year institutions. With some notable exceptions, graduates of two-year institutions are either not up to M.I.T. standards or suffer such a loss of credit that to come here would delay significantly their achieving a Bachelor's Degree.

A large number of students entering from high school bring with them through the Advanced Placement Program credit towards an M.I.T. degree.

The reduced enrollments in elementary schools across the country suggest that in a very few years the number of students graduating from high school will decrease, causing an increase in competition for the quality students that we have seen over the past 25 years. Attracting students to M.I.T. will be a challenging task for the next decade.

In fall, 1974, two part-time staff members, W. Thad Byrd and Barbara L. Moore, joined us as interns. Both made important contributions to the work of the office. Cynthia C. Bloomquist left our staff in December for the Industrial Liaison Office, and she is missed. Mr. Byrd accepted an appointment in June, 1975, as Assistant to the Director of the Educational Council during William J. Hecht's leave of absence to study for a Master's Degree at the Alfred P. Sloan School of Management.

PETER H. RICHARDSON
In September, 1974, there were 1,458 citizens of other countries enrolled at the Institute, representing 87 different nations. This total included 312 undergraduate and 1,146 graduate students. The total enrollment showed an increase from 1973-74 of 45 students, most of whom are special students enrolled in the Center for Advanced Engineering Study. There were other small increases among various departments in the School of Engineering. The other four graduate schools decreased in foreign student enrollment.

There has been a visible upward trend in the use of the Exchange Visitor J-1 Visa classification for foreign students at M.I.T. In 1970, there were 201 enrolled with this visa; there are now 301. The majority are on the M.I.T. Exchange Visitor's Program P-I-0039. This trend represents two changing aspects of international education exchange: 1) The funding of foreign students by non-U.S. sources for study abroad. Japan, Iran, Spain, and Mexico are examples of nations who sponsor their citizens either through direct grants from governmental projects or from private foundations within their countries; and 2) Many of these students are married with accompanying spouses and families. The stipends paid these students often do not take into account maintenance allowances, although some are given small amounts for their families.

Spouses with J-2 visas are still able to request permission to work for their own support from the U.S. Immigration Service. This significant feature of the Exchange Visitor's program prompts the use of this visa to assist families to remain together as a unit. Many of the spouses holding the J-2 visa are employed at M.I.T. or in the greater Boston area.

The so-called "return home seminar" initiated by Arvind Khilnani, '74, and other students in 1973, now has been given recognition by the Department of Humanities as a regular ongoing program.

EUGENE R. CHAMBERLAIN

In spite of the continuing recession, the Institute's graduates in 1974-75 generally found a good demand for their talents. The favorable job prospects of M.I.T. students intrigued the many newspaper reporters who called during the year to gather information about the market for college graduates. Hearing our rather positive view, they would comment on the bleak outlook they had been given at other colleges. Then they would reflect a moment and say: "Ah, but M.I.T., of course, is different."

It is a measure of the Institute's reputation that the number of employers coming to interview in the Career Planning and Placement Office rose slightly over last year. More firms recruited than in any year since 1969-70. There was also an increase in recruiting activity at the Alfred P. Sloan School of Management. Preliminary data indicate that salaries paid to graduates with bachelor's and master's degrees in engineering almost kept pace with the cost-of-living, a significant accomplishment in the economic climate that has prevailed for the last few years. Salaries paid to Sloan School graduates rose less sharply, but a Sloan School degree still held its own as a prized credential.
Demand for Ph. D. degree candidates was less strong, and their starting salaries rose only slightly. Students on the June degree list are still returning their questionnaires indicating their post graduation plans. The information returned by Ph. D. s will need to be examined carefully to see how they fared.

Considerable attention was given during the year to the problem of helping students of architecture. Informal statistics released in April by the American Institute of Architects in Washington, D.C., put the unemployment rate among professional architects at 25 percent. Architecture students are fully aware of the economic realities, but for many, architecture is the one career worth pursuing, and they will accept almost any job as a stopgap if it will keep them in touch with the profession. It is hoped that the Career Planning and Placement Office will be able to add a part-time staff member next academic year to enlarge its help to students in architecture and planning, humanities, and the social sciences.

The Office, in conjunction with the Office of the Dean for Student Affairs, offered a seminar in the fall term in which undergraduates visited professionals at their place of work. The seminar was particularly intended to help minority students see at first hand the kinds of career opportunity for which M.I.T. offers preparation. The seminar attracted a small but enthusiastic class, including some upperclass as well as first year students, and it will be repeated next year.

The recession made itself felt in the area of alumni placement. The number of alumni registering with the Office rose appreciably, to some 620 from 557 the previous year, and the number of job vacancies reported to the Office fell significantly. Many alumni said that they had not had to look for a job since they graduated, sometimes 20 years ago. A large portion of staff time was devoted to counseling on career alternatives and approaches to job hunting.

ROBERT K. WEATHERALL

Educational Council

The most enduring source of strength and renown for any university is the calibre of its graduates. The quality of those graduates clearly depends upon the educational construct of the university. However, it also reflects the calibre of candidate that the university is allowed to admit. Maintaining the high standards of M.I.T. ’s entering class is the primary mission of the Educational Council. The efforts of more than 1,000 volunteers and the staff in Cambridge go toward the fulfillment of that mission.

We actively engage in many continual communications efforts throughout the year. Travel, written material, bulletins, and special mailings continue. Two new types of programs are worth noting. We successfully engaged in several central meetings of potential applicants, parents, and Educational Council members in cities distant from Cambridge. A second effort was informal spring meetings held with admitted applicants, Educational Council members, and recent graduates to more effectively communicate the current image of M.I.T.

This year we continued our highly successful program of informally engaging Educational Council members with students during the Alumni Officers Conference. All of these efforts met with heightened enthusiasm and redoubled efforts on the part of our alumni volunteers. Clearly these volunteer efforts allow us to extend our reach to a broad number of students whom we could not otherwise serve.
I conclude this report on a highly personal note as I leave to spend a year away as an Alfred P. Sloan Fellow. I have found the efforts of the individual Educational Council members in the service of M.I.T. to be of the highest order. I owe each of them a great debt for helping me to understand and appreciate more fully the richness and meaning of an M.I.T. undergraduate education. I owe much also to the Council staff -- Mary Manning, Phyllis Kleid, and Susan Singer. Thad Byrd, Assistant to the Director in my absence, inherits not only the work of the Council but its pleasures.

WILLIAM J. HECHT

Student Financial Aid Office

The financial aid year was one of continued growth in most areas, the reflection of the unrelenting increases in costs relative to students' ability to meet these costs from their own and their families' resources.

Need

Financial need continued to be the sole criterion used by the Student Financial Aid Office for apportioning aid, and aggregate need continued to grow. While it is premature to draw conclusions on the strength of a single year's experience, it does appear that the puzzling annual reduction in the number of aid applicants with need has ceased. The number of needy undergraduate aid recipients was about the same as in 1973-74, and we are now projecting an annual increase in that number with greater confidence. The integration of the family income tax form as the principal means of assessing financial strength seems to be complete -- the change has met with approval from the students and their parents.

Nationally, 1974-75 was marked with considerable discussion of the definitions of "need" for purposes of determining the allocation of financial aid. The College Scholarship Service (CSS), custodians of the need analysis system and guidelines long espoused by M.I.T., proposed a major shift in their analysis parameters for use in 1975-76. Debate was intensive, relating the obvious need for a proper response to severe inflation (as it has impinged upon families' ability to pay for college) to the equally important need to maintain a sound economic and philosophical basis for the need analysis system. The upshot has been a departure, on the part of M.I.T., the Ivy League, and several other high-cost colleges and universities, not from the principles of the CSS system, but from the specific "parents' contribution" tables that CSS has offered for 1975-76 aid. The discussions will continue throughout the coming year and hopefully will result in a fully acceptable national system of need analysis.

The Office continues to be responsive to requests for help from students falling outside the defined boundaries of "need" -- our loan funds and lines of credit are being put to good use to solve the cash flow problems endemic to the upper-middle-income family.

Overall, we are conscious that the volume of personal interviews with students has increased markedly over the last two or three years, partly the result of increased use of the loan programs by graduate students, but also in part the result of our conscious effort to improve communications with our clientele and to encourage their own involvement in the decisions affecting their financial concerns. During the year, three of our staff spent most of their time in personal interviews.
Scholarships

This important element of financial aid is exhibiting a disturbing stability. While costs and needs are rising dramatically, the generation of new resources for scholarships remains a steady and slow phenomenon. We remain grateful for those new gifts and additions to existing endowments that we did experience. Two bright spots deserve particular note. The Class of 1950 has designated its record-breaking 25-year gift as a new endowment fund for scholarships, and we are sure that this fund will add considerably to our ability to help the less needy family. At the other end of the need spectrum, the Federal government's Basic Grants Program was open to freshmen and sophomores in 1974-75; the amounts paid to our especially needy students from this program rose from $14,000 in 1973-74 to $74,000. The program is obviously becoming significant. In 1975-76, it is expected to assist four undergraduate classes and should exceed $100,000 in awards to M.I.T. students.

Looking to the future, we are hopeful that the launching of the M.I.T. Leadership Campaign for new capital will benefit greatly the financial aid program by garnering significant new scholarship endowment resources.

Loans

The use of our loan funds, and the prospects of continuing capital resources to sustain them, showed little change in 1974-75 from 1973-74. The National Direct Loan Program was funded by Congress at a level which allowed us to meet most undergraduates' loan need in this way; the Technology Loan Fund was the principal loan resource for graduate students and for all foreign nationals.

Employment

The Student Employment Office this year continued an aggressive role in identifying jobs on and off campus for students during the academic year and the summer. Despite a reduction in the appropriation of funds under the Federal College Work-Study Program, a sizable program of employment in the graduate area also was successfully implemented. These combined efforts, plus development of traditional realms of student employment at the Institute, led to a payroll of approximately $2.5 million, engaging some 3,300 M.I.T. students in part-time work.

Staff

At the end of 1974, J. Bradford Haley resigned his position as Assistant Director to take a new position with the Student Loan Marketing Association in Washington, D.C. Nelson Armstrong, a recent graduate of Dartmouth College, was welcomed to the staff early in 1975 and holds the post of Assistant Director.

JACK H. FRAILEY
During the new Co-Directors' first full year, the Office of Personnel Development (O.P.D.) continued to emphasize internal development and program evaluation. By the end of the year, the number of people using the programs and services of the Office had increased from approximately 1,500 in 1973-74 to 2,400 (some persons may be counted more than once in these totals). This was achieved despite the fact that the Office was staffed at the end of the fiscal year by 3.5 fewer employees than at the beginning. Teams of staff members have been actively engaged in studying the functional program areas with a view toward providing cost-effective, quality programs to as many M.I.T. employees as possible.

Last year's pilot workshop, Human Processes in Organizations, produced significant demand for similar programs. Partly because of a difficult budget situation, it was important for the Office to accelerate internal staff development activities. It was necessary to explore the potential of job enrichment and to develop a supportive structure within the Office in order to meet these new demands.

The Office now has improved information about user response to its programs. Participant evaluations are regularly sought and summarized. Such input has been extremely useful in planning and program development. In the case of the human processes workshops, evaluation data goes beyond participant reports and includes pre- and post-test attitude measurements.

**Internal Development**

Internal personnel development and training has been built into weekly O.P.D. meetings attended by all Office employees. In addition, several intensive workshop sessions were held to focus on particular problems or issues of concern, such as defining the mission, functions, and responsibilities of O.P.D.; exploring alternative management styles; addressing problems relating to the issues of workload equity; and developing criteria for performance reviews in the Office.

As demands for new activities increased throughout the year, most O.P.D. personnel were actively engaged in performing various new related functions. Nine members of the Office participated on workshop teams for at least one human processes workshop. Others were involved in evaluation and organization research projects. Reassignments and personnel changes based in part on internal studies and evaluation of O.P.D. activities resulted in considerable savings in personnel costs. Skill training programs reached approximately the same number of students as during 1973-74, with three people performing the work previously accomplished by 5.5 people. Tuition assistance administration also was streamlined considerably with associated reductions in costs.

Internal development activities of the Office were fully documented in the thesis of a graduate student from the Sloan School of Management.
**Human Processes Workshop**

The original pilot workshop conducted last fiscal year generated a number of requests that similar workshops be presented at the departmental level and with intact work groups. Nine workshops, each typically consisting of eight three-hour sessions scheduled over a period of six to eight weeks, were presented during this fiscal year. Approximately 200 M.I.T. faculty, staff, and employees have participated. Five additional workshop adaptations for 1975-76 are now scheduled, with other requests pending.

While no two workshops are identical in all respects, the basic format and objectives are similar. The primary objectives are as follows:

1) to develop basic interpersonal communication skills;
2) to provide opportunities for skills practice through structured group activities; and
3) to introduce concepts and methods such as decision-making models, the nature of effective work groups, organizational problem solving, leadership styles, group development models, and interpersonal interaction patterns.

The workshop format promotes active participation through structured activities designed for individuals and small groups. In addition, lectures and discussions on concepts, techniques, and methods are conducted with the total workshop group.

Although small groups are utilized, the workshop approach to human relations training is very different from the unstructured group approach referred to as "sensitivity training." The goal of human processes workshops is to develop in participants effective interpersonal skills through a structure which focuses on those human skills which can be learned. Workshop group members participate in refining the general goal of improved effectiveness by more precisely identifying the knowledge and skills they wish to develop. Initially, basic active listening techniques are modeled by workshop staff and practiced by participants in structured activities. Later, these basic skills are practiced and reinforced as the group engages in learning more complex skills, such as problem solving and decision making.

Workshop learnings are applicable to both personal and work situations, but the emphasis of the content and activities is organizational. In general, workshop activities follow a pattern of movement from abstract, hypothetical content toward more specific, relevant content.

The nine workshops conducted by O.P.D. during 1974-75 were carefully evaluated. Pre- and post-test measures of participant attitudes toward self and interaction showed a positive trend. Participant evaluation questionnaires completed at the close of each workshop were also positive. Of those who completed the questionnaires, 97 percent gave the workshop an overall rating of good or excellent; 97 percent indicated that they would recommend the workshop in its present form to colleagues and co-workers; 94 percent indicated their own interest in participating in future workshops of a similar nature; 77 percent recommended that future workshop groups be comprised of heterogeneous groups of M.I.T. personnel (i.e., different payroll categories).
Organizational Development

The Office engaged in a number of different organization development activities during the past year. These included both research and action groups.

Training and consultation services were provided to two intact work groups. These groups were comprised of all those who worked together within a unit, including managers. The programs were designed to develop work group skills in problem solving, decision making, and interpersonal communications. Goals, objectives, and activities of the training involved in these services are described more completely in the Human Processes Workshops section of this report.

Requests for training and consultation from three additional intact work groups in both academic and administrative departments have been received by the Office. These new programs are planned to begin in the fall. The Office also has responded to numerous requests for problem solving and process consultation within M.I.T. organizational units.

One request for consultation resulted in the design, administration, analysis, and feedback of an opinion survey of worker attitudes in a large M.I.T. organizational unit. Out of a total of approximately 200 people working in the unit, 75 percent participated in the survey. Survey results were shared with the total membership of the unit. Study groups were formed for a more in-depth exploration of the results in order to make recommendations for procedural and organizational change.

Tuition Assistance Plan

Approximately 600 M.I.T. employees participated in the Tuition Assistance Plan in 1974-75. An increasing number of these employees are taking advantage of the opportunity for career-related study, a trend indicating the growing interest of M.I.T. employees in career development. Surveys of user experience indicated that people were generally satisfied with the Plan and its administration. Most suggestions for change involved expanding the Plan in scope and budget.

The percentage of participants reaching the $625 yearly maximum for off-campus study nearly doubled (to 13.6 percent of those studying) in the calendar year 1974. This was largely due to tuition increases in area schools: a March, 1975, survey of 12 area colleges indicated an average 13.2 percent increase in tuition costs over the past three years. A proposal to increase the M.I.T. Plan's yearly maximum was not approved for cost reasons. Alternative proposals to streamline the Plan are being examined in an effort to improve the benefit to employees without increasing cost to the Institute.

Orientation and Information

Approximately 500 biweekly employees were invited to attend 35 sessions of the Orientation and Benefits Program during the year. These sessions are held to acquaint newcomers with information resources on campus; educational and recreational opportunities in the community; basic policies of salary review and promotion; and the provisions for health and life insurance, annuities, and retirement. The results of an evaluation questionnaire, completed by those who
recently participated in orientation sessions, are being analyzed as input for an updated program in the coming year. The Office plans to enlarge the program to include those people who now receive only an individual benefits interview.

The "Secretary's Handbook," produced and edited annually, was renamed "A Guide to M.I.T.'s Administrative Offices." Of its 120 pages, some 50 were revised and distributed in October, 1974, to the departments, laboratories, and centers using the 750 copies in circulation. The change in name seemed to attract attention to the Guide's usefulness and to stimulate renewed requests for it.

Skills Training

Approximately 250 M.I.T. employees enrolled in classes in skills training. Of those enrolled, 150 received certificates for course completion. Courses were offered in Typing I and II, Technical Typing, Shorthand I and II, preparation for General Education Development (GED) examinations, and English as a Second Language. During this fiscal year, skills training classes were started at Lincoln Laboratory with approximately 50 enrollees.

Other Personnel Development Programs

Approximately 90 staff and exempt employees participated in the Administrative Development Program during 1974-75. This program, administered by O.P.D., continued to be taught by the Alfred P. Sloan School of Management faculty. When A.D.P. VI begins in fall, 1975, its participants will be selected from a group of new and prior applicants. Pending applications currently number approximately 100. The Office continues to coordinate the participation of M.I.T. administrators in the Institute of Educational Management at Harvard University.

The Co-Directors were named employee coordinators for the Independent Activities Period this fiscal year. The Office presented three activities for students and employees during the period: a communications skills workshop, a videotaped problem solving activity, and a technical typing activity entitled "Learn to Love the Equation." Approximately 30 students and 30 employees participated in these activities. Both students and employees reported satisfaction with the opportunity to share learning experiences together.

Career Development

Although no formalized career counseling programs were offered by the Office, many of its programs may potentiate career growth for M.I.T. personnel. These include human processes workshops, A.D.P., tuition assistance, and skills training.

The Office participated in the design and analysis of a career development questionnaire administered to a cross-section of 400 employees by an Alfred P. Sloan School of Management graduate student. The questionnaire also has provided current program information to the Working Group on Office-Clerical Issues.

Individual career counseling was provided in relation to other programs and on request. An intensive, formalized group-oriented career counseling program was proposed for fiscal year 1976, but, due to M.I.T. budgetary constraints, was not funded.
Other Activities

The Office again provided administrative support for the Institute's annual fall campaign on behalf of the Massachusetts Bay United Way and the United Black Appeal. After the campaign, this function and all associated records were transferred to the Quarter Century Club.

An up-to-date mailing list of 700 persons who hold academic, administrative staff, or exempt positions, including department heads, laboratory and center directors, is maintained by the Office for general as well as personnel office use.

F. ADAM YAGODKA
MAUREEN M. YAGODKA

Office of Personnel Relations

Wage and Salary Administration

A new position classification study applying to members of the administrative, academic administrative, and library staffs was put into effect at the end of the year. The new program provides for the administration of salaries on the basis of analysis and comparison to the content of the various positions, using a formal evaluation plan. Each position has been assigned to a classification and each classification to a grade having a salary range commensurate with the level of duties and responsibilities. The program was developed with the aid of an outside consultant and involved wide participation by the staff members affected, their supervisors, and senior officials of the Institute. It is expected to provide more consistent and equitable administration of salaries and more effective utilization of personnel, and to broaden and clarify career opportunities.

Working groups of employees, supervisors, and administrative personnel were appointed to study and make recommendations to the administration on a variety of issues affecting office and clerical personnel, including compensation, communications, performance evaluation, and career development. Initial recommendations providing for significant change in the salary review process were adopted and used for the review which was effective on April 1. At year's end the working group was continuing its studies and has defined a number of specific projects to be worked on during the summer.

Union Relations

Two-year agreements with unions representing 1,650 employees in six collective bargaining units expired July 1, 1975. Negotiations on the terms of new agreements continued into the fall, and were concluded in October after strikes of approximately three weeks by the Service Employees International Union (AFL-CIO), representing maintenance and custodial employees in the Physical Plant and Housing Departments and at the Lincoln Laboratory, and by the Cooks and Pastry Cooks Association (AFL-CIO), representing Dining Service and Faculty Club employees. The strike issues were economic, and the settlements provided for wage increases of 7.5 percent in each year of two-year agreements, a change from a contributory to a non-contributory pension plan, and some lesser improvements in fringe benefits.
Administration of Benefits

The reporting, communications, procedural, and other requirements of the new Employee Retirement Income Security Act (ERISA) posed problems of workload and staffing in the benefits area. A staff member was transferred to the Personnel Relations Department to work on communications, and a task group was appointed to take responsibility for ensuring compliance with all provisions of the Act.

Work was completed on a new personal statement of benefits for members of the faculty and staff. The statements will be distributed during the summer. Among other changes and improvements, the Tax Deferred Annuity Plan was extended to all Institute personnel, and the first of a series of annual reports on the operation and financial experience of the Retirement Plan for Staff Members was distributed to all members of the Plan.

ROBERT J. DAVIS

Office of Personnel Services

In its second year since the reorganization, the Office of Personnel Services has continued its efforts to serve and be accessible to personnel at the Institute, as well as the applicants who contact the Office through appointments, resumes, and telephone inquiries. The identification of a specific personnel officer with Institute areas of responsibility has been strengthened through another cycle of annual salary reviews, through work on the administrative staff classification study, and in the daily contact with administrators, faculty, and all employees on nonacademic payrolls.

Employment Analysis

Total Institute nonacademic employment as of March 31, 1975, was 5,562 people: 4,378 on campus, and 1,184 at Lincoln Laboratory. Efforts to increase the representation of minorities and women resulted in a total of 15 percent minorities, a 6 percent increase over last year, with 8 percent black, up from 5 percent last year. Women at the Institute comprise 41 percent of the total population; on the Institute's administrative staff, 30 percent are women, as are 13.4 percent on the Sponsored Research staff (22 percent of the Sponsored Research staff on campus are women). Additionally, 6 percent of the administrative staff are minority group members (4 percent black), and 6 percent of the Sponsored Research staff are minorities (1.3 percent black).

The posting of all available positions in Tech Talk has continued to be a major factor in providing promotional opportunities to Institute employees and in recruiting individuals from outside the Institute. Tech Talk, plus other M.I.T.-related sources, such as relatives and friends of current or former employees and students, resulted in more than 60 percent of the some 3,600 applicants. Of the total number, about 3,000 were interviewed by the Personnel Services staff, nearly 2,500 were referred to available positions, and almost 600 were hired (24 percent of those referred). These figures include 632 black applicants, 414 of whom were referred to departments, and 85 of whom were hired (20.5 percent of those referred).

Internal employment activity was particularly active; from April 1, 1974 to March 31, 1975, 358 current employees were interviewed in the Office of Personnel Services for transfer and
promotional opportunities, and 49.7 percent of these transfers secured new positions (37 percent the previous year were successful in transferring). In these difficult economic times when people are reluctant to leave stable work situations, it is impressive that half of those applying for a change in position were able to make that change successfully within the Institute. These figures dramatically indicate the expansion of knowledge about job opportunities, reinforce the transfer process as a positive one for all involved, and provide strong support for the job posting system.

Committee Work

While applicant and transfer activities reflect the volume of work of the Office of Personnel Services in a quantitative sense, the staff also has actively participated throughout the year on committees within the department that have addressed a variety of policy questions such as parental leave, leave without pay, and lay-off policy. The focus of other committee work has related to subjects including search procedures for staff appointments, grade and position classifications within the biweekly and other payrolls, and efforts for positive resolutions of employee grievances. Although these problems are far-reaching and the effort devoted to their solution is great and time-consuming, the staff feels a need to pursue these questions in order to continually update the service of the Office and to clarify Institute policy.

Some staff members, in addition to their normal duties, have given service to the Institute in other ways, such as Jack Newcomb's involvement with Employees' Day, and Claudia Liebesny's writing of a weekly column in Tech Talk on employment questions and answers. Ms. Liebesny also has served actively on the Working Group on Office-Clerical Issues and its on-going subgroups. Members of the employment section, specifically Kenneth Hewitt, have taken an expanded role in the organization of the Summer Employment Program for the Youth of Cambridge.

New Programs

Some internal space changes resulted in better proximity of the employment section to the reception area and reconstruction of the typing test area to reduce noise and create a more conducive testing area.

The appointment of John L. Mack as Staff Recruiter was an expansion of the recruiting effort to widen the pool of available, qualified candidates specifically for the Sponsored Research area. Mr. Mack, an M.I.T. alumnus, has made considerable progress in developing outside resources as well as working internally with personnel officers and departments on employment and search problems.

A formalized system was instituted to record, track, and respond to the more than 4,000 resumes received by the Office each year, either as responses to general or Tech Talk advertising, or as general inquiries.

Work on the design and development of a computerized applicant, transfer, and resume referral data summary system will result in its implementation on July 1, 1975. The system will accommodate the nearly 4,000 applicants, some 600 transfers, and the 4,000 additional resumes that comprise the yearly volume of activity in the Office of Personnel Services. Continued progress also has been made in our goal of combining the payroll-personnel data systems into an integrated computer file.
An opportunity to train employees in interviewing skills was made available to three biweekly staff members who quickly and eagerly assumed responsibility for their applicants for interviews, referrals and reference checks, and worked with personnel officers to learn the mechanics of setting salaries for final offers. Their training has provided needed backup to the regular interviewing staff and has provided a unique career development opportunity for these employees.

JAMES J. CULLITON

Planning Office

The report for 1975 must begin by noting that it was a benchmark year. It was the end of a planning period begun in 1960 as the Institute embarked on the Second Century Fund campaign, and it is the beginning of a new planning and development period announced this year.

In 1960, the Long Range Planning Report described the Institute as a diverse community of 10,000 people using 2.5 million square feet of space, 2,150 parking spaces, and 114 acres of land in Cambridge. The report projected that, given the proposed operating and development policies, the Institute would, by 1975, be a community of about 16,000 people. We reached that number this year. The report outlined a need for 1.2 million square feet of additional space for academic purposes. With the new chemical engineering building, we will have added a total of 2.4 million square feet to the academic campus in this period. A need for an additional 2,000 parking spaces was projected along with a minimum of 12 additional acres of land. Our parking resources increased by 1,300 spaces during this period, and our land inventory for academic purposes increased by 16 acres to a total of 130 acres.

The planning report listed a number of unresolved issues at that time. They included: student housing, libraries, parking, landscape, faculty residence near the campus, the belt highway, and the lack of a city plan. Some of these issues have been tackled over these last 15 years; significant progress has been made toward the solution of others; and some issues continue to require our attention and resources.

Now in 1975, we are once again beginning a development program designed to strengthen the Institute. However, this time we are in a period very different from the 1960s, a period of great economic uncertainty, but also one of great new challenges and opportunities. In this spirit, the Planning Office has focused its attention on providing support for the new development program, continuing its long range planning activities in transportation, campus development, the Institute's library system, and the improvement of the campus environment. We continue to search for ways to develop close working relationships with our surrounding neighborhoods, and we have worked hard to present in proper perspective the Institute's place in the city to the community at large.

We continued in 1974-75 to prepare proposals for new and expanded academic, research, and residential facilities and to oversee their design and development. Twelve separate projects were in various planning stages during the course of the year.

Our space management program provided for more than 60 space changes involving 720 of the Institute's 15,000 rooms. The information system supporting our campus physical information needs (INSITE II) has been utilized to explore a number of new policy issues, including an examination of the present formulas governing overhead recovery for Federally supported research on the campus, the School of Engineering self-study, an analysis of classroom utilization, and a new automated inventory of our parking spaces and their utilization. Through the vehicle of our Office of Facilities Management Systems, the use of
Planning Office

our INSITE II system by other institutions and organizations has increased 100 percent, bringing the current total to 10. A number of the participating institutions are using the Institute’s Information Processing Center (I. P. C.) and have thereby generated new financial resources for the Institute.

The Planning Office once again offered a summer session program on facilities management systems, attracting 50 students from the U.S. and abroad. Members of the Planning Office staff have served on a number of Institute committees in connection with the Staff Classification Study and the Bicentennial. Several have contributed papers and made presentations of the tactual maps for the blind, developed at the Planning Office, to professional conferences and continuing education programs across the country.

Long Range Planning

Long range planning was concerned this year with a number of projects which will have major impact on the Institute’s development in the years ahead.

Transportation/Circulation/Parking Plan Review

The work of the staff centered on the following:

1) Review of recommendations stemming from the study with the Parking Committee which resulted in priorities for development projects for the year.

2) Designs for projects aimed at alleviating congestion in the northern area of the main campus, the creation of visible ramps for the handicapped, and the provision of additional secure bicycle parking.

3) Response to Environmental Protection Agency (EPA) regulations affecting parking and transportation, resulting in an Action Plan of compliance for M.I.T. early in the year, explorations of alternative strategies with the EPA, and public comments this spring regarding revisions in the regulations. Finalized regulations will demand a continuing effort within Long Range Planning over the next year to coordinate transportation and parking plans for the Institute.

East Campus Development Plan

Building upon the report produced last year, studies resulting in alternatives for a development methodology have been completed and will be presented at the beginning of fiscal year 1976.

Landscape and Sculpture Plan

Within the context of the Institute’s Landscape Plan, an inventory of campus sites suitable for the placement of sculpture has been completed.
Art Facilities

Liaison with the Faculty Arts Committee, headed by Professor Donlyn Lyndon, involved wide-scale exploration of arts activities and facilities at M.I.T. and has resulted in a scheme for making the arts an integral component of the M.I.T. environment. A site location study for the placement of a special gallery dedicated to the photographic arts was completed and a program outlined which integrated this facility with related arts activities on the Walker Tennis Courts site. A research and experimentation facility was constructed which has been used to explore photographic exhibition techniques.

Bicentennial Planning

The planning staff provided assistance to the Bicentennial Visitors Committee through the development of an action plan for meeting the needs of an expanded visitor population expected through the next year.

Development Campaign

The planning staff has provided assistance in the development of proposals for a number of new programs envisioned by the new development program. We expect this activity to rise sharply in the next year as the campaign gets under way.

Community Development

Major efforts were made in the area of community development this year. More needs to be done, both with regard to specific projects in which the Institute has a direct interest and to the general status of the city's economy. Our work centered on four areas.

Simplex

A comprehensive review of the status of the development possibilities of the former Simplex properties was undertaken and a number of new development proposals will be available for consideration. The general economic climate and the specific political climate in Cambridge will likely make this project a long term enterprise.

Kendall Square

Liaison and monitoring activities with local agencies were a significant part of the Kendall Square work program. In addition, a Neighborhood Advisory Group with representatives from East Cambridge, the Kendall Square Businessman's Association, and 100 Memorial Drive has been organized and meets regularly in order to provide ongoing citizen participation in the project.

Community Relations

Two major innovations were developed and implemented during this year. One was a series of dinner meetings with Cambridge residents to discuss M.I.T. -Cambridge relations. The other project was the publication and distribution of a brochure titled "The Universities and the City," which was produced with Harvard University.
Cambridge Plan

In addition to these three project areas, work progressed on the Cambridge Comprehensive Plan and other city planning and zoning issues such as proposed ordinances dealing with design review, height limitation, and signs. Liaison was established with representatives of the Cambridge Planning and Development Department, as well as with the Chamber of Commerce and other groups.

Project Planning: Building Program and Design Review

During the past year building programs, proposals, and studies were prepared for the following projects: Athletic Facility, Central Animal Care Facility, Furnishings for West Campus Housing Facility, Proposal to National Cancer Institute for renovations and alterations of additional space for Center for Cancer Research, Study for storage for "Lesser Used Books" M.I.T. Library System, and Study for the Webster Building (E40).

The design review of projects under way was accomplished in periodically scheduled meetings, which included the project architects and members of the client team for each project.


2) Design review of the Center for Cancer Research, including review with the National Cancer Institute. The remaining floors were completed and occupied by fall, 1974.


4) Design review of the athletic facility. Phase I preliminary schematic plans to be completed July 1, 1975.

5) Design review of the Cell Culture Center, including review with National Science Foundation with occupancy proposed in September, 1974.


7) Preparation of location studies and a site plan for the installation of a sculpture by Pablo Picasso. The sculpture is sited at the head of Amherst Street adjacent to the Hermann and Sloan buildings.

8) Design review for the School of Architecture and Planning projects for environmental design, visual documents facility, Department of Architecture headquarters, Department of Urban Studies and Planning office.

9) Design review of Geophysical Vault constructed at the Westford Observatory.

10) Design review of renovation projects at Baker House for floor, lounge, and mezzanine.
Space Administration

Administrative services for more than 60 space change projects were provided during the year. Such services varied with each project, but generally they included limited or extensive planning, preliminary cost estimating, scheduling considerations, negotiations with competing activities, surveys, and studies. Approximately 720 rooms were reassigned with the authority, approval, or direction of the Committee for Space Planning.

Planning Systems and Administration

In 1974-75, with the beginning of each semester, a new cycle was initiated of updating the INSITE data base and reporting on M.I.T.'s space inventory. For each cycle, five basic reports (a building room list, a department room list, a building user summary, a department summary, and a major user summary) were prepared and distributed to the appropriate administrators. Because the general economic situation brought the Institute's financial operations under close scrutiny during the year, the data base and INSITE's reporting capabilities became a major factor in several important analytical efforts aimed at administrative considerations. One was the Engineering Task Force Report on Direct Charge for Space; a second was an examination of overhead recovery by the comptroller; a third was a more detailed space use inventory for the School of Engineering; a fourth was an analysis of classroom utilization; and a fifth was the development of an additional data file, on automobile parking space, to support the work of the Institute's Parking Committee.

The Planning Office made continuing use of the computerized internal project control program which monitors the expenses of our task-oriented budgets.


In closing this report, I would like to express my appreciation to the Planning Office Staff for their frequently tireless efforts on M.I.T.'s behalf and to the many M.I.T. community members with whom we have had the pleasure of working during this year.

O. R. SIMHA

Affirmative Action Program

Three decades ago under the Roosevelt administration, the passing of Executive Order 8802 began the legal life of the "equal employment opportunity" concept. This order required all government contracts to include a clause prohibiting discrimination by reason of race, religion, color, or national origin.

Since then, with each succeeding President, there have been several major revisions of the original concept. President Truman, for example, in Executive Order 9981 established a Committee on Equality Treatment and Opportunity in the Armed Forces. The Kennedy administration, in Executive Order 10925, originated the term "affirmative action" which...
specifically required contractors to take affirmative action to provide for equal employment opportunity for minorities.

The most extensive revisions of the equal employment opportunity concept were made by the Johnson administration in 1965 with the passing of Executive Order 11246. This Order was amended in 1967, 1968, and 1969, to prohibit discrimination on the basis of sex as well as on the basis of race, religion, color, or national origin. These amendments set forth specific guidelines for implementing affirmative action programs in educational institutions.

These significant periods in the history of the development of the equal employment opportunity concept, to a large extent, coincide with the development of the affirmative action program at M.I.T. The Institute has demonstrated, with increasing vigor, its commitment to the concept of "equal employment opportunity," and continues to support and endorse the principle of "affirmative action."

It is difficult for some to recognize the current representation of minorities and women employed at the Institute as significant, and they have adopted the attitude that the achievements are "not anything worth shouting about." If progress were evaluated only in terms of absolute numbers, one could not disagree with this statement. Retrospectively, however, the Institute's record of achievement in terms of "demonstrated effort" far exceeds projected numerical goals. Progress is virtually impossible without groundwork.

It is important that we continue to lay the groundwork by utilizing our resources to look honestly at ourselves -- to continue the close examination of policies and procedures that guide Institute employment practices. Only in that way will we continue to transcend legal and contractual requirements imposed by government regulations so that we can earnestly be about the business of providing equal employment opportunity for men and women of all races and nationalities, not simply because we are required to, but because it is right and proper that we do so.

Summary of Employment Changes in Minority and Women Representation at M.I.T.

The following is an analysis highlighting achievements and shortfalls in those classifications which are of particular concern.

Analysis of Faculty Change

The Institute has made significant progress in the hiring of women faculty. In November, 1970, there was a total of eight women (2 percent) on the faculty. As of March, 1975, there were 58 (5 percent) women faculty members, 11 less than the Institute's July, 1975, goal. To date, there are four minority women on the faculty, one black and three oriental.

Total minority faculty has increased over the years but not at the rate of women faculty. In November, 1970, the Institute had a total of 53 (6 percent) minorities on the faculty. As of March, 1975, minority representation had increased by 15 (7 percent).

The most acute shortfall has been in the hiring of black faculty. In 1970, there were eight (1 percent) black faculty out of a total of 947. By March, 1975, black faculty representation was 18 (2 percent) and the July, 1975, goal is 31 (3 percent). Of the faculty members promoted or granted tenure during the year, two were black, four were of other minority groups, and ten were women.
Analysis of Administrative Staff Change

Since November, 1970, the Institute's increase in hiring women and minorities in administrative staff positions has been significant. In 1970, M.I.T. had a representation of 53 (14 percent) women in administrative staff positions, 11 (3 percent) blacks, and 12 (3 percent) total minorities. The shortfalls have been in hiring blacks, while the goals for hiring women were exceeded. As of March, 1975, minority representation was 29 (6 percent) and the July, 1975, goal is 40 (9 percent); women, 143 (30 percent) with a goal of 131 (30 percent); blacks, 20 (4 percent) with a goal of 31 (7 percent). Of 29 people receiving promotions in 1974-75, 20 were women, and 7 were minorities. Of the 60 people newly hired, 23 were women and 8 were minorities.

Analysis of Sponsored Research Staff

This area continues to be of major concern, particularly regarding black representation. In 1970, Institute representation on the sponsored research staff area included 18 (1 percent) blacks, 174 (9 percent) women and 88 (5 percent) total minorities. As of March, 1975, black representation was 19 (1 percent) with a goal of 35 (2 percent), women 191 (11 percent) with a goal of 189 (14 percent of an expected smaller base), and total minorities 86 (5 percent) with a goal of 93 (7 percent). Again, our achievements for other minorities and for women have been more consistent with our goals.

New Developments in Affirmative Action Requirements

Since the development of the Institute's affirmative action plan for hiring and promoting minorities and women, several laws have passed which require affirmative action programs to ensure access to equal employment opportunity. The most recently enforced provisions are Title IX of the Education Amendments of 1972, Vietnam Era Veterans Readjustment Act, and Section 503 of the Rehabilitation Act of 1973 (which requires a written affirmative action program to employ and promote the handicapped). Title IX of the Education Amendment of 1972 prohibits sex discrimination in any educational programs and activities that receive or benefit from Federal financial assistance. All public or private institutions that receive Federal monies are covered. There is an admissions exemption for private undergraduate colleges, but these institutions are not exempt from other prohibitions covered in the regulation. On June 11, 1974, the guidelines for implementing this regulation were sent to all college and university presidents for comment on the subparts outlined in the proposed guidelines.

The Institute organized a task force of eight persons from various areas within the Institute that would be affected directly by those proposed regulations. The representatives were from graduate and undergraduate student offices, student housing, student financial aid, medical benefits, and personnel services. The task force met for several weeks, and each representative (with the assistance of others in their organizations) prepared a written statement commenting on each section of the proposed regulation. In addition, the Institute's legal counselor was contacted to advise on the legal implications of the requirements in each major subpart. On October 25, 1974, the Institute submitted comments to the Department of Health, Education, and Welfare (HEW). HEW received some 3,000 comments from individuals, colleges and universities, and elementary and secondary schools. The final regulations are scheduled to take effect on July 21, 1975.
Affirmative Action Program

Based on the study done by the task force, the Institute is in compliance with the Title IX rules and regulations. No written action program, numerical goals, or special record keeping are required. It is required, however, that continued efforts be made to provide equal opportunity.

The Vietnam Era Veterans Readjustment Act of 1974 requires contractors with Federal contracts in excess of $10,000 for the procurement of personal property or nonpersonal services (including construction) "to take affirmative action to employ and promote in employment qualified disabled veterans and veterans of the Vietnam era." The Labor Department has not yet announced the details of administering this law.

Section 503 of the Rehabilitation Act of 1973 was designed to provide employment opportunities for qualified physically and mentally handicapped individuals. The law requires that an affirmative action program to employ and promote qualified handicapped individuals be written by persons who hold contracts to provide either personal property or nonpersonal services to the Federal government.

For several months a task force of eight people whose organizations will be affected by this regulation have met to discuss and understand its implications and impact. This group includes the Planning Office, the Medical Department, Personnel Services, handicapped employees, a Lincoln Laboratory Personnel representative, and the Admissions Office. (The Admissions Office soon may be covered under regulations in Section 504 of the Rehabilitation Act of 1973, which covers those who do business under Federal grants and Federally assisted contracts.) To date, the task force has developed specific goals and objectives and recommends that they be adopted by the Institute when developing the plan. The first draft will be ready by August 1, 1975.

Institute Update of Numerical Goals and Timetables

As a part of the Institute's affirmative action efforts, biennial numerical goals are projected and timetables established for the employment of minorities and women. Each department will submit an update of its goals by July 15, 1975. These goals in the aggregate will be the Institute's goals for 1976-77.

Affirmative Action Efforts During 1974-75

There were two events this past year which deserve special recognition primarily because of the interest and attention given the affirmative action program by senior officers of the Institute, not in a peripheral manner, but rather in a substantive one. The first event was the meeting of the Equal Employment Opportunity (E.E.O.) staff with members of the Academic Council, and the second was the May 10 Academic Council meeting.

On April 15, 1975, members of the Academic Council requested a meeting with E.E.O. staff to discuss the progress and problems of implementing the Institute's Affirmative Action Program. The E.E.O. staff prepared a list of general areas of concern which were brought to the attention of Council members, and provided a statistical update of minority and women employees at the Institute. Several items on this list were discussed at length. President Jerome B. Wiesner summarized the discussion by indicating that
The two major areas of concern were recruitment and supportive structure for minorities and women at the Institute. He invited the E.E.O. staff to meet with members of the Academic Council in an all-day meeting on May 10, to discuss further the subject of affirmative action. At that meeting, each Council member was asked to provide an affirmative action report on the problems and progress in areas that report directly to him or her. This meeting must be viewed as an attempt on the part of each senior officer at the Institute to give special attention to progress made towards implementing affirmative action goals and objectives.

Affirmative Action Communication: Internal and External

The HEW guidelines state that "formal and informal internal and external communication of the policy of the plan is necessary to inform and secure the cooperation of organizations within the community, including civil rights groups, professional associations, women's groups, and various sources of referral within the recruitment area of the institution."
The following is a summary of both formal and informal professional and nonprofessional affiliations of the Assistant Equal Employment Opportunity Officer at M.I.T.: 1) Associate Regional Director elect for 1975-76, College and University Personnel Association; 2) Secretary, New England Minority Women Association; 3) National Association of Affirmative Action Officers, local association; 4) NAACP: Committee on the Recruitment of Minorities; and 5) Cambridge YWCA: consultant for the development of an Affirmative Action Plan and member of the personnel committee.

PATRICIA A. GARRISON

Office of Child Care

The Office of Child Care counted nearly 550 inquiries concerning care for preschool-aged children during fiscal year 1975, an increase of 37.5 percent over estimates for this period. Of those 550 inquiries, 276 resulted in applications being made to M.I.T.-related child care services -- 95 to Family Day Care (F.D.C.), 32 to the day care center, and 149 to the nursery school. Actual enrollment totaled 172 -- 47 in F.D.C. (in addition, 11 children were placed in non-M.I.T. family day care homes with whom we maintain some contact), 14 in the day care center, and 111 in the nursery school. (The number of placements does not represent the total number of children using the program except for the nursery school; e.g., while 47 children were placed in F.D.C., 53 actually used the program during fiscal year 1975. In the day care center, 14 children were placed, but 32 children actually used the center.)

One of the factors which accounts for this higher-than-expected increase in demand is the state of the economy and the fact that more mothers are becoming part of the work force. An even greater problem, however, is the fact that the number of day care spaces available in Cambridge has decreased over the last year. Further decreases are expected in the next six months because of both rising operating expenses and the high cost of renovating available space in order to meet licensing requirements.

It is therefore essential that we find new sources of money if we are to continue to provide child care services at a reasonable cost to families. A major portion of the Child
Care Coordinator's time and energy will be directed toward this effort in the coming year. To that end, discussions have been initiated with the Development Office for assistance in identifying and soliciting funds from persons or groups who might be potential donors to such an activity.

In the meantime, we continue to provide child care services of a high quality to as many families at M.I.T. as we are physically able to accommodate. We have worked extensively over the last year with our Family Day Care providers to develop a training program that addresses itself to the problems with which they have to cope. In addition to attending monthly group sessions, almost all of our F.D.C. providers successfully completed the Red Cross First Aid Program. As a result of this year's experience, we are currently working on restructuring and broadening our program for the next academic year.

We continue to provide administrative support to Technology Children's Center, Incorporated (T.C.C., Inc.). In addition to acting as staff to the Board, we keep all corporation records, provide complete accounting and payroll services to the day care center, and, as of July 1, 1975, we will provide the same services to the nursery school. As the Clerk of the Corporation, the Child Care Coordinator continues to play a major role in the business of T.C.C., Inc.

Both the day care center and the nursery school continue to operate in the black, although it has been necessary to increase fees by nearly 10 percent. (In the nursery school, the increase does not apply to children of M.I.T. students.) In both programs enrollment has stabilized, and although the day care center goes into the summer slightly less than fully enrolled, this appears to be a pattern not unusual in an academic environment.

Our involvement with the State Office for Children and with local community groups continues in an effort to ensure the availability of quality child care. While the struggle is an uphill one, we will continue to be involved in whatever ways we can.

All in all, we feel we have had a productive and successful year. Although the year ahead will be one of hard work, we approach it with enthusiasm and optimism.

MARGARET SAND

Lobby 7 Committee

Building 7 Lobby continued to serve the M.I.T. community as a lively arts forum for groups from inside and outside the Institute.

The first term introduced the National Mime Theatre to the Institute, and the Lobby proved to be an excellent, although untraditional, stage for mime. Marie Rhines, accompanied by Gene Bourque, performed an unusual concert of fiddle with guitar accompaniment. Three games of chess were played by the M.I.T. Chess Club in "Living Chess," the kings playing the masters and a percussionist chiming the taking of a piece with his cymbals. Barbara Wilson, '77, a figure roller skater as well as a student in the Department of Mechanical Engineering, demonstrated her talents on the wide open floor of the Lobby. "Devils and Bells" combined as a joint celebration of Halloween and Guy Fawkes Day with Stephen Erdely, Associate Professor of Music, performing Tartini's "Devil's Trill," with some additional input by Paul Earls, a Fellow in the Center for Advanced Visual Studies (C.A. V.S.), and the Church of the Advent (Boston) ringers with their handbells. The exhibition
of the work of the Fellows of C.A.V.S., which traveled through America for two years, was shown in the Lobby. Entitled "Asterisk," the week-long show featured the work of Otto Piene, Freidrich St. Florian, Michio Ihara, Paul Earls, Juan Navarro-Baldewag, Stan Van Der Beek, Alejandro Otero, Alan Sonfist, and Tsai. The Puppet Theatre Coop brought the Dancing Bear, Punch and Judy, and Crankies with them and were a great success. "Sidewalk Sam," the underfoot artist, created a Frederick Remington in chalk on the floor of the Lobby. The Institute was introduced to the M.I.T. Gospel Choir late in the first term, and it proved to be an exciting new musical group. The first term closed with "Waves" by Otto Piene at the Holiday Convocation, which was sponsored jointly with the Office of the Dean for Student Affairs.

The second term began with a performance of the Word of Mouth Chorus, a Vermont group specializing in early American music. "Cloud One," an electrostatic balloon, was an Independent Activities Period project under the direction of Chathan Cooke, Assistant Professor in the Department of Electrical Engineering and Computer Science. The Van de Graaf generator was borne by a 25-foot-diameter, helium filled, mylar balloon. The inflation in the Lobby was a trial run for an eventual August, 1975, flight in Briggs Field. "Alexander’s Feast," a minstrel group in Cambridge, returned to the Lobby with Medieval and Renaissance dance, music, and costume. On piano in the Lobby, Charles Pizer played the rags of Scott Joplin. "The Suitcase Circus" performed a combination of mime, dance, and theatre, and St. Patrick’s Day was celebrated by music by Jack Perron.

The Shakespeare Ensemble performed twice to announce their Kresge Auditorium productions. The FOOD exhibit was the focus of the activities of the second term. The exciting and controversial show was the combined effort of the Lobby 7 Committee, the Center for Advanced Visual Studies, and members of the Department of Nutrition and Food Science, with the majority of the works being produced by students in the Department of Architecture and its Film Section. The exhibit, given wide attention by the news media, featured Fritz Goro, scientific photographer, and Julia Child, who demonstrated the virtues of the egg.

The Central Main Power Company performed a beautiful concert of their own vibrating instruments. In May, the Wellesley Madrigal Singers returned, and a special dance group from Wellesley performed a series of dance-like games. The inclement weather on Alumni Day forced "Three Period Pieces" inside Lobby 7. The work by the dance group New England Dinosaur, Otto Piene and his Multi-Media Workshop, and Paul Earls, featured the dance group carrying large helium filled mylar balloons to music by Mr. Earls.

The graphics and publicity for the Lobby events were designed and produced at M.I.T., with the collaboration of Design Services, the Coordinator of the Lobby 7 Committee, the Department of Architecture’s Visible Language Workshop, and the M.I.T. Press. The graphics were once again unusual experiments and often outstanding works.

The Information Center in the Lobby was improved by the large scale map of Building 7. For the summer visitors, an information booth in the Lobby under the east balcony was added by the Bicentennial Visitors Committee. The Lobby coffee stand was replaced by a converted laboratory bench donated by the Department of Chemical Engineering. In late August, 1975, the cable television group under James Roberts of the Center for Advanced Engineering Study plans to install a monitor for the network under the north balcony of the Lobby.

SUZANNE R. WEINBERG
Vice President, Financial Operations

In the past, all reporting on financial operations was included in the Report of the Treasurer, an abbreviated version of which appears in the Annual Report of the President and the Chancellor. Beginning in 1976, the annual reporting format will reflect changes in responsibilities and organization of the Institute's financial management, voted by the Executive Committee of the Corporation in 1973. These changes have redefined the functions of the Treasurer, separating them from the management of financial operations which report to the Vice President for Fiscal Relations and the Vice President for Financial Operations. The Treasurer of the Corporation is responsible for the stewardship and enhancement of the Institute's assets and investments. The Vice President for Fiscal Relations has responsibility for external fiscal relations and for the Institute's purchasing policies and services. The Vice President for Financial Operations has responsibility for the following functions: Comptroller, Accounting, Finance, Lincoln Laboratory Fiscal Office, and Office of Sponsored Programs. A report on the Office of Sponsored Programs is presented in this section.

STUART H. COWEN

Office of Sponsored Programs (O.S.P.)

Highlights

For fiscal 1975, the total volume of sponsored research on campus increased by more than ten percent over the level of fiscal 1974. Once again programs related to health and energy showed the most significant growth. The Seeley G. Mudd Building was dedicated in March and represents the most significant addition to on-campus research facilities during the year. The Chemical Engineering Building, meanwhile, is moving rapidly toward completion by the end of 1975.

The decline in graduate student support, resulting primarily from the reduction in Federal fellowships and traineeships, has continued, but the number of graduate students employed as research assistants on grants and contracts has increased. To further encourage their employment on research projects, steps have been taken which will reduce the cost of research assistants on such projects, effective for fiscal year 1977.

Campus Research Volume

The total volume of sponsored research performed on campus in fiscal year 1975 by the academic departments and interdepartmental laboratories is expected to exceed $83 million (excluding subcontracts in excess of $100,000) once final figures have been compiled. This
represents an increase of more than ten percent over the comparable volume for fiscal year 1974, which in turn represented an increase of 4.8 percent over fiscal 1973.

The increase in the 1975 research volume was experienced in research sponsored by both Federal and non-Federal sources. However, there were fairly significant shifts in the level of sponsorship within each of these categories. Funding from the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (which was established in mid-year and absorbed most of the AEC) increased by nearly 16 percent over the level of AEC support in fiscal 1974. Funding from the Department of Health, Education, and Welfare increased by nearly 22 percent and funding from the National Science Foundation (NSF) by slightly more than ten percent. Support from the Department of Defense and the National Aeronautics and Space Administration remained at the 1974 level. In the non-Federal area, support from industry and foundations increased substantially while overall sponsorship from state, local, and foreign governments remained at the 1974 level.

The preliminary estimate for fiscal 1976 is that total campus volume (excluding major subcontracts) will increase by more than ten percent, to a total of approximately $92 million.

New Research Facilities

The Seeley G. Mudd Building, which houses M.I.T.'s Center for Cancer Research, the Cell Culture Center, and the Arteriosclerosis Center, was dedicated on March 6, 1975. Formerly a factory, the building was completely renovated and rebuilt to provide new laboratory and research facilities for the three centers on six floors, with about 80,000 square feet in gross area. This was made possible by a grant from the Seeley G. Mudd Fund; and by construction grants for the Center for Cancer Research from the National Cancer Institute of the National Institutes of Health, for the Arteriosclerosis Center from the Ambrose Monell Foundation and the National Heart and Lung Institute, and for the Cell Culture Center from the NSF.

The Center for Cancer Research, the largest of the three centers, is non-clinical, and its 70 researchers, including professors and students, are approaching cancer research at the level of basic research, divided into four major areas: virus research, cell biology, immunology, and cell development. The Center is supported by grants from numerous agencies, including the National Cancer Institute and the American Cancer Society.

The Cell Culture Center was established in 1974 and is funded by NSF to provide cells and viruses in mass quantities to researchers, primarily in New England and the northeastern part of the United States.

The Arteriosclerosis Center was established in 1971 to study the causes and prevention of arteriosclerosis, or hardening of the arteries, with particular attention to atherosclerosis, the most common cause of heart attacks and strokes. The Center is operated in cooperation with the Massachusetts General Hospital and is funded by the National Heart and Lung Institute and the Ambrose Monell Foundation.

In spring, 1975, the new Harvard-M.I.T. Rehabilitation Engineering Center, with clinical facilities located at the Children's Hospital Medical Center in Boston, was established under a $335,000 grant to the Harvard Medical School. The Center is a joint effort of the three institutions, under the auspices of the Harvard-M.I.T. Program in Health Sciences and
Technology. The grant was awarded by the Social Rehabilitation Service of the U.S. Department of Health, Education, and Welfare, and continues a grant first made to M.I.T. in 1972 by the same agency. The Center is one of five such programs in the nation established under the Vocational Rehabilitation Act and is the only one in New England. Children's Hospital Medical Center will be the clinical site for all of the initial work.

Early this spring, the University of Michigan, Dartmouth, and M.I.T. Astronomy Consortium was established for the purpose of relocating the University of Michigan's 52-inch wide Cassegrain-Coude telescope from its site near Ann Arbor to the Kitt Peak National Observatory in Arizona. The move was made possible by a $100,000 grant from the Alfred P. Sloan Foundation, and the three consortium members raised the additional funds needed to move the telescope and to construct two buildings to house it and the research staff. At an altitude of 6,300 feet, one advantage of the new location will be a steadier atmosphere, resulting in clearer images and at least ten times greater efficiency than was possible at the telescope's former location. The new facility complements the existing optical telescope facility at M.I.T.'s Wallace Observatory, 40 miles north of Cambridge, which has two telescopes, a computer-controlled 24-inch and a 16-inch.

At the close of the year, the shell of the new Chemical Engineering Building was completed and closed in, and the interior work was progressing rapidly. The target date for occupancy is December, 1975.

Graduate Student Support Programs

During fiscal 1975, approximately 356 graduate fellows and trainees received $2.5 million in Federal support independent of specific research projects (but including National Institutes of Health training grants), compared with 400 students who received $2.6 million in fiscal 1974. Thus the decline that began from a high point of 800 students in 1969 has continued. Next year, the total number of graduate fellows and trainees supported by Federal programs will decrease to about 325.

In fiscal 1975, graduate research assistant salaries totaled approximately $7,750,000 paid to an estimated 1,140 graduate students, compared with salaries of $6,927,000 paid to 1,070 graduate students in fiscal 1974. In 1976, the number of research assistantships is expected to remain at approximately the same level.

As noted in earlier reports, increasing concern has been voiced over the high cost of research assistants and whether they can continue to be supported at current levels on research projects, as the cost of research escalates while project budgets remain relatively fixed. Several studies were conducted over the last two years on alternatives for reducing the total cost of research assistants to grants and contracts. As a result of these studies, a change in the method of charging research assistants has been adopted for implementation in fiscal 1977. It will have the effect of reducing their cost to research programs, thereby providing greater incentive for their employment.

Personnel Changes

During the year, the following staff changes occurred in the Office of Sponsored Programs: Jane Kosut, formerly Administrative Assistant in the Cambridge Branch Office of the Atomic Energy Commission, joined the staff in September, 1974, as assistant to the director, while
George Prendergast, formerly assistant controller, Tufts Medical and Dental schools, joined O.S.P. in February, 1975, as assistant director. On April 1, 1975, Michael T. Leonard, assistant director, transferred to the M.I.T. Press to serve as financial manager. On the same date, Charlotte A. Lathrop and Mary Louise Atkinson were promoted to assistant directors. In May, 1975, Francis T. Conroy, formerly a consultant to the M.I.T. Press, was appointed as assistant director, with a special assignment as full-time subcontract administrator in conjunction with the reorganization of the O.S.P. procurement function. On June 30, 1975, Robert L. Van De Pitte, assistant director, transferred to the Center for Cancer Research as administrative officer, and Paul H. Quinn, who had held that position at the Cancer Center on a half-time basis since mid-1972, returned full-time to his O.S.P. assignment as research coordinator with broadened responsibilities in the area of grants management.

GEORGE H. DUMMER
Vice President, Operations

As the past year has witnessed intensification of economic stringency and budget reductions, the loyalty and inventiveness of the operating complement continue to be abundantly evident. As with so many organizations, M.I.T. 's efforts to conserve energy in all forms now dominate much of our operating style and decision making. The section which follows, covering some of the activities of the Physical Plant Department, indicates the gratifying progress to date. Not so obvious, however, is the fact that the easy and obvious actions in this regard have now been taken. However, additional savings more and more require sustained effort and sound engineering. This we are getting from our capable staff. Maximizing the effectiveness of our maintenance effort is another area where the rewards are real and significant. In conjunction with experienced consulting help, new procedures and organizational changes are in motion which give every indication of paying off importantly in this respect.

Providing a comfortable and pleasant environment for our students is ever a concern of the Institute. In this regard, two significant items are noted in the following reports. One is the coming on line of our newest undergraduate residence. When occupied this fall, it will represent two years of much planning and hard work. Its interior arrangements and program differ from any existing dormitory and its success will be watched with much interest. Second is the progress being made in our transition from a food service managed by an outside contractor to one where the Institute has reassumed that responsibility. A full year has passed in this new mode. In these times of significant changes in university feeding problems and opportunities, we feel the need for flexibility and responsiveness. Nothing in the experience of this past year suggests anything different. Our new management team is hard-working, experienced, and eager to meet the challenge ahead.

Physical Plant - Utilities

Energy conservation continued to be the principle concern of Physical Plant during the year. The environmental engineer's office and the Energy Conservation Committee (ENCON) continued to produce substantial benefits through the initiation and continuation of campus energy conservation activities. In April, 1975, the Department published and distributed to the M.I.T. community a report which summarized activities during calendar year 1974, after a full year of intensive energy conservation effort. The report disclosed that reductions in consumption of heat and electricity reduced the Institute's potential energy cost for the year by something in excess of $1,000,000, reflecting reductions of 25 percent in the use of steam, 17 percent in the consumption of electricity, and 48 percent in the use of air conditioning energy.

Primary emphasis for energy conservation continues to be directed towards the newer buildings with high unit energy consumption. A program was initiated to develop and implement control strategies for heating, ventilating, and air conditioning equipment which permit suitable environmental conditions to be satisfied at minimum cost.
During the year, the success of the new demand limiting computer system (IBM System/7), which was activated in December, 1974, pointed to the desirability of additional power management (i.e., "on-off" clock control, cycling, and load shedding) for those facilities not connected to the System/7 operation. As a result, numerous time clock controls were installed and are being added to critical heating and ventilating equipment systems. These controls are simple low-cost units with a high payback potential. A much-expanded computer controlled facilities management system is being actively pursued at this time.

Life safety as well as environmental comfort and economy has been and continues to be an important part of ENCON considerations. Physical Plant maintains a close liaison with the Safety Office and the Environmental Medical Service on these activities. Since the operation of fume hoods represents a formidable obstacle to significant additional energy savings in our Chemistry and Life Sciences buildings, cooperative tests of fume hood operation under limited ventilation programs have begun. These test results will hopefully point to areas where future ENCON programs can be initiated.

The campus-wide effort to reduce excessively high lighting levels continues on a programmed basis. The group re-lamping program, now in its fourth year, has been expanded to include careful de-lamping as an adjunct to the normal washing and re-lamping activities. Where possible, student help has been utilized to make light level measurements and de-lamping decisions which affect the working and living environment.

During the year, there was a significant review of the design and operation of the Institute's primary chilled water distribution system. As a result, alterations to certain secondary connections and a change in the actual operating design philosophy of the system are underway. The anticipated result of the implementation of these changes is to conserve energy input to the primary system by reducing its flow requirements.

Physical Plant - Administrative Services

Major internal administrative activities centered about the general areas of data processing, purchasing, stockroom operations, and the Work Control Center. In the area of data processing, further refinement of the generalized cost system approach was made. These techniques were transferred to other interested parties at the Institute, including the Medical Department. In addition, the system was expanded to meet the requirements of the Telecommunications Office, and personnel from that office were trained to interact with it. In consultation with the Comptroller's Accounting Office, new purchasing procedures and policies have been developed and implemented. A restructuring and realignment of the people involved has been worked out which is expected to enhance the capability of the Department in this area.

The number of M.I.T. departments and laboratories served by the Physical Plant stockroom continues to increase. This augments the ability of the Office of Laboratory Supplies to meet the research and instructional needs of the Institute community. The technique for physical inventory has been converted from an annual shut-down basis to cycle-counting, with the workload spread out over a number of months. Liaison with the Audit Division continues with respect to records reconciliation and control of access to the stockroom.

Substantial revisions have been made in the Work Control Center. One-way, high frequency voice pages have been issued, encoder and transmitter links made, and clerical personnel trained in their use. The Center has been restaffed and restructured as a result of work done during the year by an organizational consultant.
**Physical Plant - Engineering and Construction**

In the area of major construction, several phased projects were completed during the year, including the renovation of the east wing of Ashdown House for graduate students, and the Seeley G. Mudd Building, including the Cell Culture Center, and the remainder of the Center for Cancer Research. The George R. Wallace Geophysical Laboratory and underground concrete vault in Westford, Massachusetts, were completed in February, 1975. This facility will be used for seismic research. Work progressed during the year on the Chemical Engineering Building, New House on the West Campus, and chiller unit #4 of the central utilities plant. Substantial delays were experienced during the year due to strikes by several major construction unions. The chiller unit is scheduled for completion in June, the housing facility in September, and the Chemical Engineering Building in December, 1975. Larger renovation and renewal projects active during the year included laser research facilities in the Department of Physics and the Research Laboratory of Electronics, undergraduate facilities in the Department of Mathematics, women’s locker facilities at the Pierce Boathouse, and a tiered classroom at the Sloan School of Management.

**Telecommunications**

As a result of an analysis of telephone costs, the M.I.T. telephone switchboard will be closed from midnight to 7:30 a.m., effective July 1, 1975. The central M.I.T. telephone switchboards have operated on a 24-hour basis since 1952. The dormitory telephone system (Dorm Line) acquired additional equipment to provide telephone service to residents of New House in fall, 1975. In addition, a reorganization was made of administrative and technical support for radio systems used by Physical Plant and Campus Patrol.

The teletype service (TWX/Telex) provided to the Institute has become an increasingly important means of communication. The number of outgoing messages during the period of January through April, 1975, was approximately 300 percent higher than during the same period in 1974.

A physical inventory of all telephone equipment at the Institute was begun in February, 1975, and should be completed by late summer, 1975. It is the first such inventory made on campus since 1956.

**Housing and Food Services**

**Housing**

Major space changes were made in our central office facility to permit the physical merging of the off-campus listing referral service and the on-campus apartment operations. As anticipated, these changes have provided a more effective total service to the M.I.T. community and effected some economies of staffing and costs as well.

The Department underwent a traumatic experience at the start of the school year when the Service Employees' International Union, Local 254, called a strike. This affected all of our on-campus dormitories and apartment houses in the areas of cleaning, maintenance, and dormitory patrol. During this period of approximately a month, the supervisory staff...
of this Department and the Physical Plant, with the assistance and cooperation of the student residents, operated the system at a level of health and personal safety that did not impact negatively on the residents.

Renovation of the east wing of Ashdown House was completed in August, in time for the students to move in before the beginning of the fall term. This project was accomplished in two phases, with the west wing work beginning in January, 1973, and completed for occupancy in November, 1973. Work then started on the east wing. The "new" Ashdown House has been received very well by both the residents and the staff.

The new undergraduate dormitory now under construction on West Campus is nearing completion. The current schedule calls for completion on or about August 1, 1975, at which time we will install furniture. If our schedules hold, and it is believed they will, the new house will be ready for occupancy during the last week of August. Many current resident students have chosen to move to the new house, and this insures a nucleus of upperclass residents.

As an aid to increased communication with residents, members of the housing staff visited each of the dormitories to discuss the operation there and other topics of interest to residents. We believe that this communication is valuable for all concerned, and we expect to continue to visit each house at least once a term for unstructured meetings.

Mary C. Smith, a staff member of the Community Housing Service, retired in December of this year, completing three years as a volunteer and ten years as an employee in various housing areas. She was a joint recipient of the Murphy Award, which is given to employees who in the eyes of the students have made a large contribution to the quality of life at the Institute. It was a well-deserved recognition of her dedication and interest during these 13 years of service to the M.I.T. community. Also retiring are Leonard Whaley, after 30 years of service, and four persons from the hourly staff with a total of 116 years of service.

We foresee several major tasks in the coming year. The retirements from our staff, coupled with the addition of the new house, will result in significant shifting and some addition of personnel. In addition, we expect to develop a comprehensive program for furniture replacement and maintenance to meet the long-term needs of the system.

Food Service

This year's operation reflected a period of planning, adjustment, and transition. Both the "19-meal plan" and the "partial plan," tried for the first time this year, have been well received. In addition to the daily operations, we have developed new menus and recipes and have implemented a program of purchasing based on competitive pricing.

The transition to a food service run entirely by M.I.T. resulted in a significant change of personnel. We note two of these several changes. Suzanne Hansen joined the staff as Food Production Supervisor and was promoted to Executive Assistant to the General Manager. Guy Guidone was promoted to Manager of the Walker Memorial Food Services, replacing Robert Radocchia.

Food service to the community was temporarily suspended last fall as the result of a strike by members of the Cooks and Pastry Cooks Association, Local 186. Service to all contract customers was continued in Walker Memorial by supervisory and student personnel with assistance from members of the Institute community. Normal services resumed on October 14, about a month after the strike began.

In the year ahead we will be working to improve the existing operation and develop new programs. The current partial contract plan will be replaced by a new one that offers greater
flexibility and responds to requests for a "dinner only" option. We will be seeking increased community input regarding types of service needed and suggestions for improvements.

**Campus Patrol**

On most days, a visitor to Campus Patrol headquarters would observe a level of activity which many members of our community would find surprising: reports involving larcenies, a lost child, a medical emergency, motor vehicle problems, a disturbed person, a fire alarm, an intruder, and so on. Although incidents of violent crimes against persons at M.I.T. decreased this past year, total property thefts on campus nearly doubled. The value of thefts of Institute property rose from $22,000 in 1973 to approximately $40,000 last year. Dormitory thefts totaling $13,000 in 1973 soared to $33,000. About 25 percent of the stolen property was recovered through investigation, arrest, and through pawn shops.

M.I.T. is intimately linked to its urban environment and there is clear evidence that the economic pinch and a rising crime rate experienced by the surrounding neighborhoods is reflected at the Institute. This requires greater efforts in crime prevention with frequent reminders to the M.I.T. community on ways to assist in this effort. This past year, bulletins about the following were distributed: identification of property, a "Bolt Down" program for office equipment, Patrol escorts, bicycle security, dormitory theft advisories, safety for women, firearms laws, car thefts, and others. More than 37 percent of the stolen property was taken from open unattended areas, despite frequent advisories.

Reducing auto theft is a vexing problem. The Boston area has the highest record of stolen cars in the nation, so last year's 50 percent increase in the M.I.T. area evokes little surprise. The Patrol continues to produce, distribute, and publicize information on this problem.

Ambulance runs in 1974 rose to a high of 1,175 as the Patrol made excellent use of a new ambulance and equipment to better serve the Institute needs.

The Campus Patrol continued with its volunteer "Junior Beaver" recreation program for Cambridge youngsters. This effort has been highly successful in furthering our community relations program.

We are committed to an ongoing, inservice training program. Through our own efforts, and by taking advantage of exterior resources, Patrol personnel have been enrolled in special programs which continue to improve the quality of performance. More than 3,600 hours were devoted to training in 1974.

**Safety Office**

New governmental regulations on safety and health matters continue to have an impact on Institute operations. Our involvement has ranged from testifying with respect to new state regulations on safety showers to complying with Occupational Safety and Health Administration (OSHA) requirements on carcinogens and Energy Research and Development Administration requirements for accelerators. Additionally, a new state building code was promulgated January 1, 1975, to be enforced by the cities and towns instead of by the Department of Public Safety. Several projects already have been processed through the City of Cambridge and a positive relationship established.
The program of auditing fraternities for safety continues, with greater emphasis on detailed analysis including cost studies for fire insurance and building rehabilitation. Six fraternities were involved this year in addition to one undergoing major renovations.

OSHA-type inspections at the Institute have been completed, with the exception of classroom areas. During recent safety tours, a marked improvement in basic safety awareness throughout the Institute has become evident. A need still exists, however, for continual monitoring of all activities on a day-to-day and personal basis. This means that we will have to rely more and more on the departmental safety coordinators, who are doing a creditable job.

The often perplexing task of disposing of hazardous waste chemicals has been abated somewhat due to the emergence of a reputable, Environmental Protection Agency approved, disposal contractor who recycles, reclaims, incinerates, or buries the waste. The Institute is no longer a party to ocean dumping of wastes.

Other highlights of this past year include a program of education and training in the use of ground fault interruptor electrical protection for all Physical Plant shops and building service groups. A study was made of vehicular accidents, which is to be followed by a proposal to the Safety Committee for a vehicle safety policy. The first annual survey of all computer installations (valued at over $50,000) was undertaken in conjunction with the Treasurer's Office, to comply with insurance requirements. The installation of an emergency generator in Bexley Hall and a complete sprinkler system in Eastgate corridors and other public spaces were accomplished. The reviews of many experiments and projects prompted installation of a liquid oxygen/fuel system for Building 31 and the replacement of the core of the nuclear reactor. A marked increase in first-aid training, and contacts with student organizations were other highlights.

The number of fires continued to decrease with 17 reported this year versus 29 the year before. Only two fires resulted in sprinkler actuation. The industrial accident rate measured in terms of dollar losses per 100 employees also continued to decline favorably. With the exception of 1972-73, we have experienced a distinct downward trend over the past seven years.

Graphic Arts

The total volume of Graphic Arts business done with the M.I.T. community was up approximately 20 percent for the year. This, along with the previous year's increase, represents a 35 percent total increase in volume over a two-year period. Prices charged have remained relatively stable over this time. In some cases, they have actually been reduced, despite major increases in cost. This is due to greater volume, along with new and improved methods and equipment.

The Quick Copy Centers continue to grow. First, at the request of the Departments of Mathematics and Chemistry, a new, small, copy center, with one machine and operator, was opened in Building 2. So far, this has proved to be a valuable central service for these departments and, at the same time, has enabled them to divest themselves of the inefficient and costly copy machines which they had been managing.

A much needed space change was made in the Alfred P. Sloan Building, wherein operations were moved from two small locations on the fourth floor to one larger, more efficient location in the basement. At the request of the Sloan School of Management, Graphic Arts now handles not only copying and duplicating needs, but also the School's distribution of class material to students at this location. This has proved to be of considerable benefit to all.
New and modern equipment was obtained for the central location in Building 3. This included a color copier which will copy a full range of colors with good clarity, a multilith duplicator capable of reproducing on both sides of a sheet of paper, and a copy machine capable of copying same size from originals as large as 14" x 17". Including the new equipment, there are 15 duplicators and copiers now operating in the Copy Centers.

The offset printing, photographic, illustration, and mailing services have also showed increases of approximately 20 percent. The photographic operations was helped by the purchase of a complete photomechanical transfer process (PMT) which was installed in September, 1974. This process is able to generate sharp, reproducible, direct positive results either on paper or film through automatic processing, quickly and inexpensively.

Endicott House

Endicott House, celebrating its twentieth year as an M.I.T. department, had a very good year in spite of initial expectations to the contrary. The house was again open 12 months of the year, but received light use in July, January, and February. Other months compensated for this, and we are able to report that the house was used a total of 275 days, including 205 nights by resident groups, which is a significant increase over last year's usage.

Measures of the year's activity are as follows: 23 resident conferences were held during the year. Overnight guests totaled 5,134 or an average of 25 per night. Of this number, nine were M.I.T. resident groups, accounting for 4,196 overnights; 14 were non-M.I.T. resident groups, accounting for 938 overnights. There were 89 non-resident groups, with a total of 5,887 guests, using the house. Of these, 63 were M.I.T. groups and 26 were non-M.I.T. groups. A total of 21,203 meals were served during the year, an average of 77.1 meals per day of operation. Truly, this was a busy year.

Although we increased our rates as of July 1, 1974, due to still further escalating operating costs, we find it necessary to raise our rates again, effective July 1, 1975. Measures to operate as effectively as possible and to still retain the essence of an Endicott House experience are much on our minds these days.

We have continued our program of capital improvements, including installation of a new 3,000 gallon oil tank, numerous electrical improvements to bring us up to OSHA standards, replacement of the oriental rug in the Gun Room, and refurbishing of the bedroom furnishings.

PHILIP A. STODDARD
By and large it has been a good year for research, with many outstanding achievements. These are described in the sections that follow.

ALBERT G. HILL

Laboratory for Nuclear Science (L.N.S.)

The Laboratory for Nuclear Science provides support for research in nuclear and elementary particle physics by faculty members and associated research staff. It supports the activities of the Center for Theoretical Physics in these fields, and provides a computing facility for the theoretical and experimental programs and for some of the activities of the Center for Space Research. L.N.S. also supports experimental research programs in three areas: nuclear structure physics, with current emphasis on heavy ion physics; intermediate energy nuclear physics, centered at the Laboratory's Bates Linear Accelerator in Middleton, Massachusetts; and elementary particle physics, with current programs at six accelerator facilities, four in this country and two in Europe.

The progress of theoretical studies is reported by the Center for Theoretical Physics. Here are presented some salient developments of the experimental programs. The academic year 1974-75 was one of outstanding success for the Laboratory. The most noteworthy accomplishment occurred in the field of elementary particle physics. A team from L.N.S. working at the Brookhaven National Laboratory (BNL) discovered a new, relatively stable particle more than three times as heavy as the proton. It has been called the 'J' particle by its discoverers. The extraordinary importance of this discovery is illustrated by the fact that since publication in November, 1974, about 1,000 papers have appeared dealing with its interpretation. Public interest was also very high, and on November 26, 1974, group leader, Professor Samuel C.C. Ting, presented his findings to an Institute Convocation in Kresge Auditorium. The group is preparing followup experiments at BNL, at Fermi National Accelerator Laboratory (FNAL) in Batavia, Illinois, and at the European Center for Nuclear Research (CERN) in Geneva, Switzerland.

In intermediate energy physics, the outstanding achievement occurred at the Laboratory's Bates Linear Accelerator. This facility, directed by Professor Peter Demos, became operational in the preceding year. During 1974-75, the high precision magnetic spectrometer was put into operation. It is designed as an integral part of the facility primarily for the study of the electromagnetic structure of nuclei by inelastic electron scattering. The first results obtained with light and heavy nuclei were presented at the April meeting of the American Physical Society and at the Sixth International Conference on High Energy Physics and Nuclear Structure at Santa Fe, New Mexico, where they were generally acknowledged as opening a new era in this field of investigation.

Although overshadowed by the discovery of the 'J' particle, a number of other achievements were registered in the elementary particle field. An ingenious and relatively simple experiment carried out at FNAL by a group from the Laboratory throws new light on the initial
development of processes resulting from very high energy collisions. The results seem to indicate that when such collisions occur in an extended nucleus, the resulting fragments do not separate into their final configurations until they have emerged from the nucleus. Two major facilities were put into operation at FNAL by nationwide collaborations in which teams from the Laboratory play a leading role. Significant new results have been produced on the interaction of hadrons in the 100 GeV energy range.

Among other experiments in high energy physics, we note a study by the bubble chamber group on the interaction of negative pions in the 2 to 16 GeV energy range which has confirmed a model for these reactions proposed earlier by this group. Collaborations at CERN have produced a study of large-angle, low-momentum pion production in very high energy proton collisions, and preliminary results on the correlation of particles produced in such collisions. Another collaboration at the Stanford Linear Accelerator Center resulted in one of the first measurements of photoproduction of the 'J' particle.

In intermediate energy physics, two experimental results obtained at the Bates Accelerator have posed challenges to current theory: one concerns photoproduction of pions near the energy threshold, the other, photoproduction of protons at large momentum transfer.

Work in nuclear structure physics has concentrated on reactions of heavy ion. A sophisticated mass-energy spectrometer system for the identification of reaction products has been installed at BNL by a group from the Laboratory. Among the interesting results obtained is the observation of well-defined excited states formed by colliding carbon nuclei in which they apparently maintain their identities forming a highly deformed compound nucleus. Another group is pursuing a collaborative program of deep-inelastic scattering of heavy ions at the Max Planck Institute in Heidelberg, Germany.

This wealth of important results has produced a demand for support of followup experiments which has placed a severe strain on the resources of the Laboratory, especially in elementary particle physics. The U.S. Energy Research and Development Administration (ERDA) has recognized the importance of the program by providing some additional funds, but severe limitations are imposed by the current shift of emphasis to fields with more rapid social and economic benefits. During the coming fiscal year some very promising projects will probably have to be curtailed because of financial limitations.

Participants over the past year in the various programs of Laboratory research totaled approximately 460 persons. This included 56 academic staff members, 75 graduate students, and at least 104 undergraduates from M.I.T. and neighboring institutions (work-study, UROP, senior thesis, part-time "hourly" students, etc.), 62 research staff members, including visitors and guests at the Ph.D. level, and 163 employees in supporting categories (engineers, technicians, machinists, administrative, computational, etc.). A total of seven Ph.D. degrees, one Master's degree, and 13 Bachelor's degrees were completed during this period by students engaged in thesis research within the Laboratory.

Support for fiscal year 1975, received from the Laboratory's contract with ERDA totaled $7,078,000, itemized as follows: operational costs for experimental and theoretical high energy physics (salaries, wage, employee benefits, materials, services, travel, etc.), approximately $2,675,000; for medium energy physics and for support of the Bates Linear Accelerator facility and program $2,535,000; and, for nuclear structure theory and heavy ion experiments $870,000. Equipment funding under the ERDA program during this period totaled $938,000, as follows: $220,000 for high energy physics and $719,000 for medium energy and heavy ion physics. An additional sum of $60,000 was supplied for general plant projects associated with the Bates facility.

MARTIN DEUTSCH
Research Laboratory of Electronics (R.L.E.)

The Research Laboratory of Electronics, the first of the Institute's interdepartmental laboratories, was established to encourage interaction between teaching and research in the Departments of Electrical Engineering and Physics. Over the years the Laboratory has had projects involving participants from as many as a dozen academic departments. The research groups, currently numbering about 30, conduct research in three broad areas: communication sciences, general physics, and plasma dynamics.

The research in R.L.E. is conducted primarily by faculty members and students. Approximately 95 members of the faculty are affiliated with the Laboratory, working with about 295 graduate students and nearly 160 undergraduates. The research spans a broad spectrum of topics and thus provides a wide variety of opportunities for student thesis work. During the past year, this research provided the basis for 30 doctoral, ten Engineer's, 30 Master's and 40 Bachelor's theses.

Major support for the research is provided by the Joint Services Electronics Program of the Army, Navy, and Air Force, as well as the Energy Research and Development Administration, the National Science Foundation, the National Institutes of Health, and the National Aeronautics and Space Administration.

General Physics

The research in general physics is based largely on atomic and molecular phenomena. The experimental techniques required to observe basic properties of matter and to exploit them in engineering applications span most of the electromagnetic spectrum from radio wavelengths to X rays. Various experiments make use of extremely high frequency vibrational waves, liquid helium temperatures, and computers. A few of the research topics in this area follow.

Professor John G. King reports that the second-generation scanning desorption and scanning pinhole molecule microscopes are being tested and studies of absorption on heterogeneous surfaces, including natural and synthetic biomaterials, are being undertaken.

Professor Daniel H. Kleppner and Dr. Theodore Ducas have initiated studies of atoms in highly excited states. Sodium atoms in an atomic beam are excited to energy levels close to the ionization limit by two-step excitation from a pair of pulsed tunable dye lasers. The atoms in these levels are detected by ionization in an applied electric field. Measurements have been made of the ionization properties of these high "Rydberg states." These excited states are being used to investigate photoionization processes, collision phenomena, and tunneling in static and oscillating fields.

Observations of radiation from sodium dimer complexes have been made. Preliminary results indicate the presence of broad-band rapid decay fluorescence which is a signature of bound→free superradiant emission. In addition, short lifetimes have been measured for bound→bound sodium dimer emission.
During the past year, under the direction of Professor David E. Pritchard, two new techniques have been demonstrated for studying collisions of laser-excited atoms. In an approach designed to achieve highest resolution, the angular distribution of velocity-selected atoms scattered from a gas target is modified by shining an intense laser beam on the collision region. This experiment yields information about the force between the excited atom and the target.

Professor John D. Joannopoulos has evolved a new theoretical method for the study of infinite non-periodic solids which allows for the first time an exact treatment of the lack of periodicity. The method is being used to study the electronic properties of amorphous solids, surfaces, and vacancies.

Professor Jin-Au Kong and his students have pursued a number of projects in electrodynamics, including: geophysical subsurface probing with dipole antennas, passive remote sensing of the earth with microwaves, and integrated optics and optical communications.

Professor Hermann A. Haus was on a leave of absence from M.I.T. at Bell Laboratories. Visiting Professor Abraham Szoke carried on the research on saturable absorber mode-locking. The work profited from cooperation with workers at Bell Laboratories, and resulted in a comprehensive theory of saturable absorber mode-locking of CO$_2$ lasers.

Professor Shaoul Ezekiel and his students have performed highly precise measurements of hyperfine structure in molecular iodine using laser molecular beam techniques. The effects of nuclear magnetic octupole interactions due to the non-spherical charge distributions in the iodine nucleus have been observed. This is the first such observation in optical spectroscopy and should make possible a much better understanding of the magnetic field distribution in electronically excited states of atoms and molecules. To date such measurements have been restricted to the ground state only.

During the past year Professor Alan H. Barrett, Dr. Philip C. Myers, and graduate students have continued their studies of microwave spectroscopy of the interstellar medium. Dark interstellar clouds have been studied in the transitions of formaldehyde, carbon monoxide, carbon monosulfide, methanol, and ammonia, using telescopes at Haystack Observatory, the National Radio Astronomy Observatory, and the Max Planck Institute in Bonn, West Germany. These studies yielded information on the chemical, physical, and evolutionary properties of such clouds.

Professor Barrett, Dr. Myers, and graduate students have developed microwave radiometers to sense subsurface temperature anomalies in the human body. A pilot program has begun at Faulkner Hospital using these instruments in the study of the detection of tumors of the breast.

Professor Bernard Burke and his group have continued the study of interstellar masers and quasars using both conventional instruments and very long baseline interferometers. The first convincing demonstration of magnetic fields in an interstellar maser was achieved showing that in one source the magnetic field is 1.5 milligauss, which turns out to be the order of magnitude to be expected in condensing the interstellar medium if the initial microgauss magnetic field flux is conserved. A synthesis of infrared, radio continuum emission and both H$_2$O and OH maser phenomena, by Doctor Young-Sek Lo, indicates that the H$_2$O masers are probably indicators of stellar condensation at a very early stage. A study of quasar-galaxy pairs by Aubrey Haschick has shown that, in one case, the quasar certainly lies beyond a visible galaxy, and the evidence can be used to support the hypothesis that quasars do indeed lie at cosmological distances. Patrick Crane and Thomas Giuffrida discovered that the radio nucleus of a well-known local galaxy, M81, is varying on time.
scales of days to many months, the first example of such variability in the nucleus of a "normal" spiral galaxy.

**Plasma Dynamics**

A major goal of the plasma dynamics program is extension of the basic understanding of phenomena in relation to such problems as controlled fusion, space physics, and collective phenomena in solids. The research includes methods of producing highly ionized plasmas by electron beam injection, high power lasers, microwaves, low-pressure arcs and so forth. Plasma diagnostic techniques involve measurements in various portions of the electromagnetic spectrum (microwave, millimeter wave, infrared, optical).

Professor E. Victor George and his students have studied CO$_2$ laser systems to obtain further understanding of the details of the gain spectrum of the above-atmospheric-pressure CO$_2$ laser system. Absorption measurements have been performed in CO$_2$ and mixtures of CO$_2$ and He to 18 atm pressure.

Significant progress was made in the theoretical description and understanding of nonlinear wave interactions in plasmas. This work is part of a continuing project of Professor Abraham Bers and his students within the R.L.E. plasma research program. The results are important to current studies of heating plasmas to temperatures that would initiate thermonuclear fusion of light nuclei. The achievement of controlled thermonuclear fusion holds great promise as a new means for the generation of energy.

Professor Bruno Coppi, Professor Robert Taylor, Dr. Ronald R. Parker and their associates have achieved high density, high temperature plasmas with Alcator.

The Alcator experiment has produced new plasma regimes, which are of basic interest for an understanding of the physics of high temperature plasmas and, at the same time, represent steps toward the goals of controlled thermonuclear research. The basic philosophy of this experiment is to create plasmas capable of carrying large currents and current densities, in order to produce conditions where plasma heating results either from (discrete) particle-particle collisions at relatively high plasma densities, or from collective effects (microinstabilities) at relatively low plasma densities. The Alcator experiments are a joint venture of R.L.E. and the National Magnet Laboratory.

Two plasma regimes have been realized thanks to the experimentally attained possibility to vary the plasma density over two orders of magnitude. In the regime (so called "slide-away") that is dominated by collective effects, the relevant plasma modes have been well identified and correlated with the non-Maxwellian nature of the electron distribution function, whose evolution has been followed by precise Thomson scattering experiments, and with the heating of the ion population in deuterium plasmas, to the record value of 1.2 keV. Notice that turbulent heating of toroidal plasmas had been realized before Alcator but over microsecond time scales or shorter, while plasma current pulses, with non-collisional ion heating, as long as 400 msec have been obtained in Alcator.

In the regime ("nearly-classical") that is dominated by discrete collisions, the electron distribution is very close to a Maxwellian and the particle confinement time as well as the confined thermal energy density have been found to increase proportionately with the density and with different powers of the plasma current. Therefore, record average densities of $2 \times 10^{14}$ cm$^{-3}$ have been achieved with energy confinement times up to 15 msec.
High voltage pulse technology has been developed to the point where mega-ampere electron beams can be generated at megavolt energies. Such developments are expected to have significant impact in areas such as plasma heating, electron beam fusion, microwave generation, collective ion acceleration, and laser pumping. Two machines each capable of delivering 80 kA at 500 kV are being used by Professor George Bekefi and his students. During the past 18 months, significant advances have been made in the understanding of electron and plasma motion in the relativistic diodes, in particular as concerns the motion of the charged particles perpendicular to a strong applied magnetic field. By designing the diode in the form of the classical smooth bore magnetron exciting new results are being obtained on the generation of intense burst microwave power.

Communication Sciences and Engineering

This research spans a broad range of topics pertinent to communication processes in man-made and living systems, as well as interactions between them. Fundamental studies of signals and systems are coupled with various applications such as speech and picture transmission, seismic detection, and optical communication channels. A major portion of the effort is related to the life sciences. A combined program of research and training in communications bioengineering includes areas such as communications biophysics, neurophysiology, cognitive information processing, and speech communication. Much of this work concerns the sensory or perceptual mechanisms, and the related program in linguistics seeks to improve our understanding of languages which form the basis for communication.

The cognitive information processing group, under the direction of Professor Murray Eden, has continued studies of the ways in which humans process visual information and the development of automatic procedures and computational techniques for performing similar tasks.

Professor Barry Blesser and Dr. David M. Ozonoff, together with Brian Stanley, have been looking at the effect on patient management of the observer variation that is encountered when several independent interpretations are made of the same routine chest X-ray. This work was done in collaboration with the Radiology Department of the Peter Bent Brigham Hospital. Previous studies had demonstrated that such variations exist to an appreciable extent. Through the use of such analyses, it is hoped that a better picture of the cost-effectiveness of the various image processing strategies meant to reduce this variation, can be obtained.

Professor Ian T. Young has developed a measurement procedure for cell-to-cell adhesion, which he and Dr. Stephanie E. Sher have been applying to clinical samples. The measure of adhesion is being used to determine the compatibility of donor and recipient in kidney transplants, and to monitor the course of patients with myelocytic leukemias. If the measurements prove to have clinical significance, an automated system for clinical use will be developed.

Visiting Professor Goesta H. Granlund has continued to develop a system for automated analysis of human chromosomes. Procedures have been devised to allow a very precise description of the chromosome complement of an individual. This information can be used in search for chromosomal abnormalities and to establish chromosomal "fingerprints."
The "electronic darkroom" project conducted for the Associated Press by Professor Donald E. Troxel and his students has progressed to the point where a prototype system is slated for field installation during the coming year. This is a computer-based image processing system which automatically receives new photos and reroutes them to other communication channels. While the pictures are stored in the computer they can be cropped, enlarged, and enhanced by changing their tone scale or by performing unsharp masking.

Professor William F. Schreiber and his group have developed a laser facsimile system for high quality X-ray transmission. Work also has been done in typography with the design of a system for interactive computer generation of new type fonts.

Visiting Professor William Simon and Professor Eden have been engaged in the development of a technique for obtaining three dimensional measurements of blood cells by means of a scanning electron microscope. This technique has now been applied to measurements of a large number of cells and is being used in other recent projects in the cognitive information processing group. In addition, they have developed a method of producing three dimensional visual display systems for computers that require no special glasses or optical aids of any kind.

Professors Eden and Blesser, with Dr. Robert J. Shillman, have been carrying out psychophysical experiments in an attempt to discover how humans recognize handprinted letters. One goal of this work is to construct a machine capable of equaling human performance in the task of reading. In addition, a grammar of printed characters has been framed and is being tested with a variety of type fonts. The goal of this work is to construct a font-independent reading algorithm.

Professor Jonathan Allen and his co-workers have continued the development of a system for conversion of unrestricted English text to speech. Techniques for the derivation of pitch and tuning parameters from an underlying linguistic description have been developed, and an all-digital vocal tract model suitable for large scale integration implementation has been constructed.

Professor Alan V. Oppenheim and several graduate students have been applying a number of new digital signal processing techniques to speech processing and seismic data processing. The speech processing work is directed specifically toward enhancement of degraded speech as experienced, for example, on a faulty communication channel. The seismic data processing has led to the development of a number of significant new techniques which potentially will be useful for exploration seismology.

During 1974-1975, a new project began concerning the dynamic behavior of data communication networks. The principal results thus far are two studies: one by Professor Robert G. Gallager entitled "Basic Limits on Protocol Information in Data Communication Networks," and the other by Professor Adrian Segall entitled "Dynamic File Assignment in a Computer Network." The work will be expanded in the coming year as an interdisciplinary investigation involving other faculty members: Professors Michael Athans, Nils R. Sandell, Alan S. Willsky, and John M. Wozencraft, plus approximately ten graduate students with interests in the fields of control theory, communications, operations research, and/or computer system architecture.

The neurophysiology group, under the direction of Professor Jerome Lettvin, has been working on the mechanism of visual receptors and their interaction with pigment epithelium; on threshold processes in peripheral nerves, with particular attention to long term changes following activity; on normal and regenerated connections of the optic nerve in anilphibia; on an artificial larynx, now in use with patients in Buffalo; on the substantia gelatinosa of
the spinal cord, with good records coming out for the first time from this structure; on the mechanism of color vision; and on related matters.

In August, 1974, the Eaton-Peabody Laboratory of Auditory Physiology, which continues as a joint operation of M.I.T, the Massachusetts Eye and Ear Infirmary, and the Harvard Medical School, moved from temporary quarters at M.I.T. into the new Eye and Ear Infirmary building. Professor Thomas F. Weiss has collaborated with others in experimental studies of the frequency selective properties of auditory nerve fibers in a species of lizard, with the goal of understanding the processes involved in producing these properties which are of fundamental importance in hearing. Dr. Nelson Y. S. Kiang, Director of the Laboratory, and Professor William T. Peake, in cooperation with members of the clinical staff of the Infirmary, have demonstrated that, with a small computer, electric responses can be recorded from the auditory nerve of patients in an office environment and that these records may be useful for diagnostic purposes.

Research in auditory perception by Nathaniel I. Durlach and Professors Louis D. Braida and H. Steven Colburn has focused on intensity perception and loudness, binaural interaction, and aids for persons with impaired hearing.

In the first area, previously developed theoretical structures and experimental techniques have been extended successfully to loudness comparisons between stimuli having different frequency content. Also, it has been shown that sequential effects in identification arise primarily from shifts in decision criteria rather than in sensitivity. In the second area, a comprehensive review of previous research on binaural hearing has been completed, theoretical models have been extended to describe matching results as well as discrimination results, a system that provides more precise stimulus control has been implemented, and a variety of new experimental results on interaural time discrimination have been obtained. In the third area, new projects have been initiated on signal enhancement and the reduction of interference (array processing for spatial resolution and comb filtering for voice separation), on matching speech to residual auditory function (amplitude compression for reduced dynamic range and frequency lowering for severe losses at high frequency), and on tactile displays of auditory signals (directed toward listeners who have no useful residual hearing).

Work on the production and perception of musical sounds, supervised by Dr. Adrianus J. Houtsma, has included the evaluation of a stochastic pitch model by means of musical interval recognition data for dichotically presented two-tone complexes, a study of the dependence of loudness of two-tone complexes on the harmonic relation of the constituent frequencies, and an examination of the pitch of chopped white noise through musical interval identification experiments. A descriptive model for acoustic stringed instruments of the lute-type incorporating essential non-linearities in the force transformation at the instrument's bridge was developed and evaluation of the model through harmonic analysis of guitar tones is continuing.

Professors Lawrence S. Frishkopf and Charles M. Oman continue electrophysiological studies of the lateral line and vestibular organs. The emphasis of this work is on exploring mechanisms of hair cell transduction and the origin of neural adaptation. Recent observations showing sensitivity of vestibular organs to small external changes in concentrations of calcium and magnesium have led to a study of the composition of inner ear fluids in several vertebrate species. The study is being performed in collaboration with Dr. Claude Lechene of Harvard Medical School and Professor Thomas F. Weiss.

The research of the speech communication group, under the direction of Professor Kenneth N. Stevens, continues to examine the physiology, perception, and acoustics of speech, with emphasis shifting toward the study of strategies for producing and perceiving
sentences in running speech.

Recently completed projects include studies in inter and intraspeaker variability in the acoustic characteristics of speech sounds, detailed description and interpretation of wave motion on the surface membranes of the vocal cords during larynx vibration, and investigations of the role played by timing and memory processes in sentence perception. The speech communication group continues to explore the property-generating and property-detecting capabilities of the human vocal tract and auditory system, and the role these capabilities play in establishing a universal set of phonetic categories that are used in language.

As in past years, the research of Professors Morris Halle, Noam Chomsky, and others in the linguistics group has been directed towards extending our understanding of the nature of language; the acquisition of which is one of the most complex intellectual achievements that is accessible to all humans.

Within the group, several distinct approaches are represented to the basic question of the field: the character of the logical structure of linguistic theory. On the one hand, Professor John R. Ross has challenged the assumption that linguistic phenomena are discrete, and much of his work has attempted to lay the foundations for such a non-discrete theory of language. Professor Chomsky has continued to work on the so-called "extended standard theory," which he first presented publicly some years ago. Much of Professor Chomsky's recent work has been devoted to bringing these contributions together into a unified whole. A third theoretical task has been pursued by Professor David Perlmutter. Jointly with Paul M. Postal of IBM, Professor Perlmutter has been developing a theory of relational grammar which rests on and combines two basic ideas. From transformational grammar it takes the idea of a distinction between underlying and surface levels of representation, and of rules and derivations that relate them. From traditional grammar, it takes the idea that the notions "subject of," "direct object of," and "indirect object of" are basic notions and play a central role in grammar.

Phonology continues to be a major area of research. Worthy of special note here is the development by a number of graduate students (John Goldsmith, Mark Liberman, Shosuke Haraguchi) and others (notably George N. Clements) of the new theory of auto-segmental phonology. The questions that this theory originally attempted to answer concerned the role of the so-called "supra-segmental features" - mainly pitch and stress - in phonology.

HENRY J. ZIMMERMANN

Center for Materials Science and Engineering (C.M.S.E.)

The Center for Materials Science and Engineering has been housed in the Vannevar Bush Building since 1965. The aims of the C.M.S.E. are to initiate, encourage, fund, and coordinate interdisciplinary research in materials, based in large part on core-funding by the National Science Foundation (NSF), and further supported by smaller block-funds and individual grants to faculty members and groups. Faculty, staff, and students of the Departments of Physics, Chemistry, Materials Science and Engineering, and the Departments of Civil, Mechanical, Electrical Engineering and Computer Science, and Chemical Engineering participate in the C.M.S.E.; however, funding support is not restricted to occupants of the Center.

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Starting July 1, 1972, funding of a major part of the Center's programs came from NSF; prior to that time, similar interdisciplinary research funding was provided by the Advanced Research Projects Agency.

In addition to funding support, the Center provides and maintains an impressive group of central (service) facilities in support of research throughout the Institute. Supervised by senior faculty members, the facilities provide special materials, analytical services, testing laboratories, and a machine shop. The Center has more than 80 faculty and research staff members associated with it through the funding program and, on average, 40 advanced degrees are awarded to students each year. Two other activities of unusual nature are the money funding of research on new or underdeveloped ideas, and the funding of new faculty who would otherwise arrive at M.I.T. without adequate research support.

Some highlights of research, highly abbreviated, are given below as examples of the types of studies which are under way. Many programs are the result of close collaboration among several faculty members, although this will not be evident from the short resumes. For a complete view of research in materials, the reader is referred to the Annual Report on Research in Materials issued by the C.M.S.E.

Mechanical and Physical Properties of Polymers and Glasses

Professor Donald Uhlmann
The question of local order in nominally glassy polymers has received wide attention in recent years. Electron microscope observations of structures on a scale of 30-200 Å occupying a large volume fraction in nearly all glassy polymers have cast serious doubt on the standard structural models for amorphous polymers and the understanding of their mechanical properties based on these models. Current work has indicated that the heterogeneities seen in the electron microscope are not representative of the bulk materials. For every polymer investigated, the small angle X-ray scattering indicates a level of density fluctuations in the materials which corresponds closely with that expected from thermodynamic fluctuation theory for fluids applied at the glass transition. High resolution electron microscope studies of polycarbonate are in consonance with the SAXS results in indicating the absence of structure on the scale of the reported nodular features.

High Vacuum Modification of Surfaces

Professor Roy Kaplow
Treatment of atomically clean (evaporated) iron samples in pure nitrogen gas at room temperature appears to be effective in creating a permanent (possibly iron-nitride) layer which seems to retard subsequent gaseous oxidation. In particular, a sample so treated and subsequently exposed to atmosphere for a period of weeks, exhibits - under ESCA/Auger spectroscopy-prominent nitrogen spectra and the near absence of oxygen lines. This is in contrast to mechanically cleaned samples exposed to atmosphere for only seconds or minutes which exhibit dominant oxygen spectra. Visually, the vacuum-treated sample still appears clear after some months, while ordinary, unprotection iron exhibits rust to the naked eye.

Since the dissociation of N₂ molecules (to use that example) is probably a rate limiting step for simple gaseous treatments, it is advantageous to speed that process. Therefore, in a separate small high-vacuum system, assembled specifically for the purpose, we have been studying the utility of discharge (plasma) methods within the ultra-high vacuum scheme. Initial work, although bothered by what may be sputtering from the changer itself, is very
encouraging and seems to show sufficient absorption of nitrogen in short times to lead to precipitation of nitride, visible under optical microscopy.

**Processing of Oxide Dispersed Alloys**

Professor Kenneth Russell
To date, a theory has been developed for coarsening of oxides in a metallic matrix, and tested in a simple system (Cu-SiO₂). The theory predicts that, as in binary systems, coarsening should follow a \( r^3 \) vs. \( t \) time law, and show an Arrhenius behavior, with the activation energy a function of the energies of diffusion, solution, and dissolution. The experimental results generally verified the theory, including the prediction that useful oxide dispersoid lifetimes could be increased by orders of magnitude through judicious control of the processing variables. The results are being extended to an internally oxidized and hot isostatically pressed Ni-Mo-BeO alloy.

**Crazing and Fracture in Forming of Brittle High Temperature Polymers**

Professor Ali S. Argon
This research has helped establish the conditions for craze initiations and growth in glassy polymers under multi-axial stress, as may occur during deformation processing. This has put on solid foundation an earlier theory of the principal investigator on craze initiation, and helped the development of a quantitative model for craze extension. These earlier findings and currently continuing research will put the hitherto qualitative understanding of crazing and fracture of glassy polymers on a predictive basis, permitting the possible use of certain glassy polymers as structural members and their craze-free mechanical processing.

**Theoretical Investigation of Catalytic Materials**

Professor Keith Johnson
Electronic structure calculations, utilizing the self-consistent-field \( \text{X}\text{X} \) scattered-wave (SCF-\( \text{X}\text{X} \)-SW) method, have been completed for clusters of Cu, Ni, Pd, and Pt containing up to 13 atoms. These are prototypes of the very small clusters (less than 10 Å in size) which constitute the active centers of commercial heterogeneous catalysts. Thus far, the results for the isolated clusters suggest that the electronic structures are rather similar to those of the corresponding bulk metals. Hence, if very small supported metal clusters have different catalytic behavior from that characteristic of the surfaces of crystalline metals, which cannot be explained simply by the increased surface area, it is possible that the supporting material, usually a refractive oxide, may be involved. Much of our new research will therefore be directed to the elucidation of metal-support interactions in catalytic materials.

Theoretical studies also have been carried out on platinum-ethylene and nickel-ethylene complexes which are prototypes of reaction intermediates formed in both heterogeneous and homogeneous olefin catalysis. The effects of two types of local molecular environment on the metal-ethylene \((\text{M-C}_2\text{H}_4)\) bonding have been investigated by: 1) adding more metal atoms to the \(\text{M-C}_2\text{H}_4\) complex and 2) adding nonmetal atoms (e.g., Cl) to the \(\text{M-C}_2\text{H}_4\) complex. In both cases, the environment has a profound effect on the \(\text{M-C}_2\text{H}_4\) bonding; e.g., the Cl atoms effectively withdraw d-electrons from the transition-metal atom, thereby promoting bonding between the metal and ethylene. These studies provide simple examples of the
possible effects of the surrounding environment on metal-adsorbate bonding which, in turn, may influence catalytic activity or selectivity.

**Organic Surface Chemistry**

Professor George Whitesides

A versatile apparatus for the assembly and manipulation of oriented fatty acid monolayers has been constructed, and this apparatus has been used to prepare platinum foil hydrogenation catalysts having oriented monolayers on their surface. Initial results with these modified catalysts suggest that they show molecular sieving characteristics, (that is, they discriminate between substrates on the basis of size) presumably as a reflection of the anisotropic, size-dependent, diffusion of substrate through the monolayer film. In addition, examination of the reaction of the film components themselves appears to offer a new technique with which to study the structure of these remarkable assemblies.

A program of development of new supports for heterogeneous catalysis has yielded a group of silica-, alumina-, and carbon-based materials in which colloidal magnetite precipitated into the pores of the support renders it readily amenable to high gradient magnetic filtration. These magnetic separation techniques are being extended to other catalyst systems, and to the development of materials appropriate to new synthesis reactor configurations.

**Cathodo-optical Materials and Devices**

Professor David Epstein, Dr. Arthur Linz

A projection-type cathodochromic display has been developed which employs a single electron gun for writing and erasing a sodalite image screen. The device can be used to store and display text and picture and can be selectively erased. This effort is a continuation of a previous investigation of the crystal growth and optical properties of cathodochromic sodalite powders, a study which culminated in the fabrication of a number of different cathodochromic display devices. These offer high resolution, high contrast in ambient light, long storage time, and feature selective electron-beam eraseability. It is felt that cathodochromic sodalite is a strong candidate as material for use in optical information processing, particularly if thin transparent single crystal films can be grown. First on the program is the sputtering of doped and undoped cathodochromic sodalite of various compositions onto a variety of substrates.

**Optical and Electrical Properties of Narrow-Gap**

**Pb$_{1-x}$Sn$_x$Te**

Professor Stephen Senturia

Using our molecular beam epitaxy facility, we have achieved the lowest recorded carrier concentration ($5\times10^{17}$ cm$^{-3}$) in a film of band-inversion Pb$_{1-x}$Sn$_x$Te ($x = 0.39$) grown on a cleaved KCl substrate. This and other films have been used to measure the optical dielectric constant $\varepsilon_{\infty}$ in the narrow gap regime. We find a broad peak as a function of composition, with $\varepsilon_{\infty}$ increasing from 33 in PbTe to 60 in band inversion Pb$_{1-x}$Sn$_x$Te. Magneto-optical studies of the films have mapped out the density of states through band inversion. We find that the band model of Adler, Hewes, and Senturia is successful in describing the band-inversion region.
Thermoelectric power measurements in PbTe and in the band-inversion Pb$_{1-x}$Sn$_x$Te have revealed two new anomalies. The phonon drag component of the thermopower in n-type materials differs markedly from that in p-type material. Variations of this difference across the alloy system indicate that the n-p asymmetry is correlated with the band-edge symmetry of the wavefunction, which changes at band inversion. In addition, an abrupt change in the slope of the thermopower with temperature is observed in band-inversion samples at a temperature about 40K above the temperature where band-inversion is expected.

New device possibilities using our epitaxial Pb$_{1-x}$Sn$_x$Te films include the fast optical shutter (of Nurmikko and Pratt) and the possibility of p-n junctions in band-inversion Pb$_{1-x}$Sn$_x$Te using bismuth doping and suitable annealing sequences.

Development of an Extremely High Sensitivity Method for Measuring Displacements

Professors Carl Garland and Thomas Greytak

A new interferometric technique has been developed for measuring the amplitude of very small a.c. displacements. The technique, utilizing a spherical Fabry–Perot interferometer, is much more sensitive and less susceptible to acoustic vibrations than previous methods. We have used this technique to measure displacements as small as 4 \times 10^{-4} \AA, and the theoretical sensitivity in a well-isolated environment, is about 10^{-5} \AA. Application of the method to the measurement of the piezoelectric constant of ND$_4$Cl crystals has permitted a study of the variation in the order parameter very close to the order-disorder transition. The technique is quite general and can easily be adapted to other measurement problems.

The Role of Surface Barrier for Catalytic Reactions: Studies on Semiconductor Surfaces

Professor Harry Gatos

A piezo-chemisorption effect has been discovered whereby surface strain causes striking changes on the rate of chemisorption on non-centrosymmetric semiconductors. In the case of the basal surface of ZnO, depending on the sign of the strain, the rate of oxygen chemisorption is accelerated or decelerated by more than an order of magnitude; the magnitude of the strain can be as low as 10^{-3}. The piezo-chemisorption effect is accounted for by a model involving strain-induced changes in the surface potential barrier (surface piezoelectric effect) and the barrier controlled electron-transfer between the semiconductor and the absorbed species. This effect constitutes a valuable tool for the quantitative study of charge transfer and the role of the surface barrier in catalytic processes on semiconductor catalysts.

NICHOLAS J. GRANT

Center for Space Research

The Center for Space Research experimental program in the space sciences over the past year has been concerned primarily with the disciplines of X-ray astronomy, interplanetary plasmas, and observations in the infrared. In addition, theoretical studies in the general field of astrophysics have been active as have been projects devoted to the analysis and interpretation of data obtained from earlier space experiments. Effective assistance has
been provided by the Center's Laboratory for Space Experiments in the design, fabrication, testing, and launch support of balloon, rocket, earth satellite, and interplanetary payloads. Numerous exploratory studies have been carried out within the Center's facilities leading to new proposals to the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the Air Force, and the Navy for additional programs of space research in the disciplines of physical science, life science, and technology applications.

The research in the life sciences by the Man-Vehicle Laboratory on motion sickness and spatial disorientation together with the neuro-endocrine research group's findings on light exposure dose-response relationships have extended the Center's involvement into the manned space flight regime. The research has been under the supervision of approximately 20 faculty from the Departments of Physics, Earth and Planetary Sciences, Nutrition and Food Science, Aeronautics and Astronautics, and Electrical Engineering and Computer Science. Support personnel within the Center have included approximately 50 research staff and 35 other full-time employees. About 40 graduate students have been directly associated with the research through fellowships and research assistantships, and about 30 additional students via part-time employment.

Primary support of the Center's research comes from NASA. Additional support is supplied by the NSF, the Air Force, and the Navy.

Progress reports on active space flight experiments, payload development and associated research programs of the Center are described below. Immediately following this section are descriptions of the exploratory and more general endeavors of the Center.

The eighth Interplanetary Monitoring Platform (IMP-J) satellite was launched into earth orbit in October, 1973. This satellite carried a solar wind plasma detector developed under the supervision of Professor Herbert S. Bridge of the Department of Physics, Associate Director of the Center. Excellent data is being received from this new spacecraft, which followed an earlier launch made with IMP-H (now known as IMP-7) in October, 1972. Together, the two spacecraft will provide full coverage of the interplanetary solar wind and will allow simultaneous studies of the earth's magnetosphere for at least a year period. Senior Research Scientist Alan Lazarus and Drs. Joseph Binsack and James Sullivan assisted with the design and development of the experiment. Robert Butler supervised the design and development of the instruments. Analysis and interpretation of the data is continuing and many research topics are being studied.

The M.I.T. X-ray detector on the OSO-7 satellite which was launched on September 29, 1971, continued to operate effectively until the time of reentry which occurred during August, 1974. Among the recent results from this experiment are a long-term study of the transient X-ray source that appeared in the constellation Lupus, the discovery of a rapid change in the X-ray intensity of the radio galaxy Cen A, and a comprehensive all-sky map and survey of X-ray spectra. This research has been under the supervision of Professor George W. Clark, Department of Physics.

The third Small Astronomy Satellite, SAS-C, carrying the M.I.T. Orbiting X-ray Observatory, was launched by NASA on May 7, 1975, into a near-circular orbit at an altitude of about 513 km. Quick-look data are received and processed immediately in a dedicated computer facility in the Center for Space Research where the X-ray instrumentation was prepared. Early results showed that the Observatory is performing as planned, and that it will yield highly sensitive and precise measurements of the positions, spectra, and time variations of celestial X-ray sources. Professor George Clark is the principal investigator for the project; co-investigators are Professors Hale V. Bradt and Walter
Lewen, all of the Department of Physics, and Dr. Herbert Schnopper, formerly of the Space Center and now at the Smithsonian Astrophysical Observatory. The X-ray instrumentation of the Observatory was built at the M.I.T. Laboratory for Space Experiments under the supervision of Richard Taylor.

A new concentrator/counter system was installed in the M.I.T. sounding rocket payload to permit a sensitive measurement of the diffuse X-ray background at ultra-low energies. One successful flight (November, 1974) of this payload has yielded unique measurements of the background at these energies. A new payload, designed for X-ray imaging experiments with 4' arc minute angular resolution, is in the design stage. The X-ray telescopes for this payload are under development at M.I.T.; the position sensitive proportional counter is being supplied by the University of Leicester. Professor Bradt and Professor Saul A. Rappaport of the Department of Physics share supervisory responsibilities for this program.

The High Energy Astronomy Observatory (HEAO) Modulation Collimator Experiment (A3) is well into the hardware phase. The collimator structures and wire grid frames have been fabricated successfully. Final assembly will begin this summer. The star trackers to be used are the SAS-C spares. The operation of these sensors on SAS-C has proven to be flawless. Professor Bradt is co-principal investigator in collaboration with Dr. H. Gursky of the Smithsonian Astrophysical Laboratory.

The Mariner-Venus-Mercury interplanetary plasma experiment, under the supervision of Professor Bridge, was launched in November, 1973. The spacecraft made its scheduled encounters with Venus and Mercury, a second intercept with Mercury in September, 1974, and a third in March, 1975. The encounter with Mercury was the first intercept by a spacecraft, and showed that Mercury has a magnetic field strong enough to stand off the solar wind. The observation of such a strong field was unexpected, and it is not certain whether that field is intrinsic to the planet or is induced through an interaction with the solar wind.

The Mariner-Jupiter-Saturn interplanetary plasma experiment is under the supervision of Professor Bridge. Co-investigators include Professors John W. Belcher, Stanislaw Olbert, and Vytenis M. Vasyliunas, all of the Department of Physics, and Drs. Binsack and Lazarus of the Space Center. The prototype design of the experiment is progressing. Two separate spacecraft will be launched within one month of each other in 1977. An encounter with Jupiter is planned for 1979, at which time the experiment will study the magnetosphere in more detail than was possible in the Pioneer 10 and 11 experiments. The spacecraft then will leave Jupiter for an encounter with Saturn. The plasma investigation will make use of Faraday cup detectors, one pointed along the earth-spacecraft line and one at right angles to this line. The earth-pointing detector will determine the macroscopic properties of the plasma ions, obtaining accurate values of their velocity, densities, and pressure. The side-looking detector will measure electrons in the energy range from five electron volts to one kilo-electron volt.

The SOLRAD Program comprises a pair of identical satellites to be placed in a circular equatorial orbit of about 20 earth radii. The satellites, oriented toward the sun, will provide 100 percent real-time continuous monitoring of the solar X-ray, ultraviolet, and energetic particle emissions. The solar-wind-monitoring instrument was designed under the supervision of Dr. Lazarus by several students who made major contributions to the concept, detail design, and testing. Launch is scheduled for November, 1975.

The X-ray astronomy experiments from high altitude balloons under the supervision of Professor Lewin have continued. On August 13, 1974, a unique measurement was made
from Canada when the moon occulted the Crab Nebula. Both the disappearance and the reappearance of the Crab were observed during the flight over Saskatchewan. These measurements revealed a previously undetected elongated shape of the high-energy X-ray source. Also, it was observed unexpectedly that the pulsar NP0532 is not centered on the X-ray region.

During another very successful flight (largest balloon ever flown) on June 1, 1975, from Texas, a new transient X-ray source, A 0535 + 26, was observed simultaneously with the SAS-3 M.I.T. X-ray Observatory. The 103.8 sec period was clearly established. Light curves up to 150 keV are in preparation.

During the same flight, the following sources were also observed: the Crab Nebula, Cyg X-1, Cyg X-3 and likely 3U 0620+23. New flights are planned for October-November from Alice Springs, Australia.

The High Energy Astronomy Observatory (HEAO) A-4 of Professor Lewin (in collaboration with Professor Peterson of the University of California at San Diego) is proceeding. The expected launch date is April, 1977.

The flight preparations for the X-ray telescope on the High Energy Astronomy Observatory, HEAO-B, are continuing, with M.I.T. responsible for the focal plane curved-crystal spectrometer. An engineering evaluation model of the instrument has been completed and tested, and construction of the flight unit is under way at the M.I.T. Laboratory for Space Experiments. The HEAO-B is presently scheduled for launch in 1978. Professor Clark is principal investigator for this experiment and the project scientist is Professor Claude Canizares.

The Center is fortunate to have received continued support in the form of basic research funds on an annual basis from NASA since 1963. While the amount of this support has dwindled over recent years from nearly $1,000,000 per annum in 1966, to only 20 percent of that amount in 1974-75, the flexible nature of these basic funds continues to provide funds for exploratory research on new space experiment concepts, instrumentation development, and special studies. Active projects of this nature during 1974-75 include the further development of a computer controlled photon camera system under the supervision of Professor Clark, research on a precise pointing control system for X-ray telescopes by Professor Lewin, and studies of large area X-ray counter concepts by Professor Rappaport. Independent sponsorship of these latter programs is being sought through proposals to NASA and NSF.

Professor Thomas B. McCord, of the Department of Earth and Planetary Sciences, was assisted in his research on vidicon imagery devices for optical telescopes and also on exploratory studies leading to a comprehensive proposal to NASA for an experiment to measure the composition of the lunar surface at remote locations. This project will be part of the forthcoming Lunar Polar Orbiter Mission.

A major effort was mounted in the Center for developing the concepts and preliminary designs for radar altimeter and radiometer measurements of the Venus surface as part of the NASA Pioneer Venus Orbiter Mission 1977. Professor Gordon H. Pettengill, Department of Earth and Planetary Sciences, and David H. Staelin, Department of Electrical Engineering and Computer Science, combined with the staff of the Center for Space Research to respond to NASA's request for proposals for a conceptual approach to this mission, the development and procurement of the necessary experiment hardware and the attendant program management and launch support. Unfortunately for the Center, NASA thereupon
broke up the solicitation into hardware and scientific phases and in the follow-on procure-
ment cycle, the Center lost out to a competitor. The nature of the loss of this program
was a keen disappointment, and has raised concerns as to the future of university par-
ticipation in new NASA space experiments.

Other conceptual studies carried out under the basic funds support during the past year
included six prospective NASA Explorer mission profiles. These included determination
of the physical properties, spatial distribution, and time variations of charged particles
precipitated into the entire auroral zone; utilization of the Small Astronomy Satellite-C
protolight payload as a multiple user X-ray observatory; a large area X-ray timing
experiment; the orbiting of a large area X-ray telescope facility as a dedicated Explorer
mission; a meridional interplanetary magnetosphere mission; and finally, an investigation
of interplanetary dynamical processes including high-time resolution measurements of
the solar wind. The foregoing mission studies were directed by several faculty members
of the Department of Physics in association with the Space Center staff.

The Center's basic funds provided support for theoretical studies on fundamental astro-
physical phenomena by Professor Paul C. Joss and astronomical observations at infrared
wavelengths by Professor Susan G. Kleinmann, both of the Department of Physics. These
investigations have led to proposals for independent sponsorship in both cases, and appear
to have promising prospects.

Conceptual studies and preparation of joint proposals were carried out with Professor
Richard Wurtman, Department of Nutrition and Food Science, for determining the lighting
environmental factors affecting bodily physiology. These concepts have been incorporated
into future NASA plans for space research in the life sciences. Negotiations for direct
sponsorship are continuing.

The Center also has been active in studies concerning the use of composite materials in
space structures for communication satellites and other applications. This effort led
directly to a new research contract with the Air Force. Continuation and expansion of
this research activity is anticipated. In addition, studies of space-based solar power
systems and the analysis of the dynamics of long tethers in the space environment have
been initiated.

As reported in detail last year, the Space Center is looking to new interests in a broader
range of disciplines for space experiments using the Space Shuttle/Spacelab Earth to
Earth-orbit system. The expected ability of this space transport system to provide in-
orbit research by less than fully-qualified space flight personnel, to return experiments
to earth, and to service or refurbish flight systems while in orbit, is expected to open
up new horizons in space experimentation among faculty investigators. The Center
enthusiastically looks forward to a greater level of cooperative investigations in the 1977-
1985 time frame. However, preparatory work and plans must begin now since this type
of research program takes a minimum of one to three years to mature, and is only likely
to evolve through a sustained and active interest by key investigators in matching their
own scientific interests with the mission profiles selected by NASA for sponsorship.

This new mode of research is expected to involve a further extension of the existing as-
tronomical observatory role for space missions using larger and more sophisticated
facilities. The research also may open for investigation new spectral ranges of radiant
energy touched on only lightly in past experiments. In addition, a further concentration
on earth resources and studies of the physical properties of the earth's surface features
and atmosphere, is anticipated. As planned, free-space, zero-gravitation experimen-
tation will be possible as well as research at zero-g in a shirtsleeve environment using
enclosed laboratories manned by scientists and engineers with a minimum of special astronaut training required. We feel that M.I.T. research investigators face exceptional opportunities in this new regime, and the Center is prepared to assist and encourage the initiation of this new mode of space experimentation.

The Center has continued its close association with Professor Philip Morrison and Kenneth Brecher, both of the Department of Physics, in their important contributions to theoretical astrophysics on topics such as spinars, fluorescence theory of supernovae, models of galactic X-ray and gamma ray sources, neutron star and pulsar theory, properties of extended extragalactic X-ray and radio sources, and tests of cosmological models. NSF has been the chief sponsor of this research.

Administrative support and research facilities continue to be provided in the Center for the program of man-vehicle oriented research by Professors Laurence R. Young, Renwick E. Curry, and Charles M. Oman, all of the Department of Aeronautics and Astronautics. These studies are centered in the field of motion sickness and disorientation and the underlying physiological mechanisms associated with spatial orientation.

Closely allied to the above research is that of Professor Wurtman's group and, in particular, prospective work on dose-response relationships between light exposure and associated physiological effects of light on humans in the space environment.

The recently announced long-range program of research in the life sciences by NASA bears directly upon these special interests. The developing mutual interests for investigation in the life sciences will be important to the future research programs of the Center and M.I.T. To this end, the Center will host an in-depth workshop presentation and discussion on the future Life Science/Shuttle/Spacelab Program on July 2, 1975.

The combined effects of completing the payload phase of the Small Astronomy Satellite project and the temporary lack of replacement programs have resulted in a condition of financial stress in the engineering and payload development sections of the Center. The long-term health of the Center will depend on NASA policies toward the sponsorship of university research. Because of the overall budget restraints and the demand of the Space Shuttle Program, space science activities are being curtailed severely in NASA. Therefore, the Center is seeking new sponsors and broader areas of endeavor as illustrated by its newly acquired Advanced Composites Program for the Air Force and the Life Science Workshop for the Space Shuttle/Space Lab Program.

JOHN F. McCARTHY, JR.

Francis Bitter National Magnet Laboratory

On June 30, 1975, the Laboratory completed 15 years of operation, the first 11 under the sponsorship of the Air Force Office of Scientific Research, and the last four with the National Science Foundation as the primary sponsor. Since the start of operation of the ten megawatt power supply in 1963, the Laboratory has been the foremost research facility of its kind in the world. This position has been maintained in the face of declining support in real dollar terms, but vigorous efforts are being made in France, Germany, and the USSR to provide equal or better facilities for magnetic field research. Of course, experimental facilities alone are valueless. An imaginative and productive scientific staff must make use of the facilities to produce significant research results. Conversely, a close interaction of the scientific staff and the magnet designers is essential to insure
the maximum usefulness of new experimental facilities. Also, the number and quality of
research opportunities for graduate students and faculty are strongly dependent on the
level of the basic research program. Time and performance pressures usually associated
with applied research projects often limit student participation. It is hoped that current
efforts to restore support of the basic research effort to its former level will be more
successful than during the last few years.

Nevertheless, some important new results have emerged from the basic research program
in this past year. Ternary superconducting compounds of lead, molybdenum, and sulfur
were made and found to have superconducting critical fields greater than 500 kG at 4.2K,
the highest critical field yet found. Studies of related compounds of varying composition
and with differing preparation techniques are continuing. New high magnetic field measuring
techniques for magnetostriiction have been applied to the antiferromagnetic material, MnF$_2$.
The experimental results, along with a theoretical interpretation, have led to a better
understanding of the magnetic properties in high fields.

Experiments on Raman scattering in magnetic semiconductors, in collaboration with the
Department of Electrical Engineering and Computer Science, and the Center for Materials
Science and Engineering, have yielded new results and stimulated a theoretical explanation
of the phenomena. New studies of the spin-flip Raman laser in high magnetic fields have
clarified the anomalous behavior of the laser thresholds and saturation intensities as a
function of magnetic field.

Superconducting films of indium, tin, lead, bismuth, and gallium were condensed on
substrates held at 1K in a special evaporator to determine their critical field, density of
states, and spin-orbit scattering in fields up to 15 teslas; Zeeman splitting of the density
of states of gallium was observed. Spin polarized tunneling studies showed that films of
cobalt only two atomic layers thick are ferromagnetic. A zero-frequency superconducting
inductance bridge capable of detecting a magnetic flux of $2 \times 10^{-16}$Wb was developed.

High field magnetic moment and Mössbauer measurements have been made on a series of
high-spin iron-porphyrin complexes with oxygen and sulfur axial ligands. The mea-
measurements are crucial to the elucidation of the relationship between structure and function
in certain heme protein enzymes and, in particular, point to sulfur as the axial ligand in
the high spin form of Cytochrome P-450.

Studies of the generation and subsequent heating of plasmas by laser radiation have continued
with special attention focused on the beam self-trapping effects discovered last year. A
narrow bandwidth, far infrared methyl fluoride laser operating at 496.4nm has been developed.
A high power version of this laser is being constructed for use in Thomson scattering
diagnostic measurements in plasmas.

The Alcator thermonuclear experiment being conducted in collaboration with the Research
Laboratory of Electronics and supported by the Energy Research and Development Admin-
istration was operated during the entire academic year. An impressive range of plasma
parameters was produced. The scientific value of this work toward the nation's goal of
achieving practical thermonuclear energy sources was reflected by a sizable increase in
financial support for Alcator for the coming academic year.

The group studying the weak magnetic fields of the human body has been exploring a scheme
for magnetically mapping the lungs of workers in the asbestos industry to see if a rapid and
accurate technique could be developed for determining the asbestos content of the lung.
Preliminary results are promising.
Since 1971, the Laboratory has collaborated with the Department of Electrical Engineering in the development of a new concept in high speed ground transportation called the Magneplane system. Passive cylindrical vehicles containing magnets are supported resiliently one foot above an aluminum guideway trough by induced repulsion, and are propelled by a traveling magnetic field generated by conductors in the guideway and synchronized by information transmitted from the vehicle to wayside power conditioning units. The study culminated in the successful operation of a 1/25 scale model employing superconducting magnets on the vehicle. A decision by the Federal government to cease research on all advanced high speed ground transportation systems brought the Magneplane program to a halt this year.

In January, the Laboratory was reorganized into six groups and three projects. Group leaders are Dr. Roshan L. Aggarwal, Quantum Optics and Plasma Physics; Dr. Simon Foner, Magnetism and Superconductivity; Dr. Ronald R. Parker, Alcator; Dr. D. Bruce Montgomery, Magnet Research and Technology; Lawrence G. Rubin, Instrumentation and Operations; and Edward J. Cox, Administrative. Project leaders are Drs. Henry H. Kolm and Emanuel Maxwell, co-leaders, Applied Magnetism; Dr. Leo J. Neuringer, Molecular Biophysics; and Dr. David Cohen, Low Magnetic Fields. Dr. Aggarwal also was appointed a Senior Research Scientist in the Department of Physics.

Approximately 2,865 hours of magnet time were used in 1974-75: 42 percent in Laboratory projects, 14 percent by other M.I.T. organizations, 22 percent by non-M.I.T. organizations, and 22 percent in collaborative programs of the Laboratory and other organizations.

BENJAMIN LAX

Undergraduate Research Opportunities Program (UROP)

The Undergraduate Research Opportunities Program, now in its sixth year, is the embodiment of strong feeling in the Institute that undergraduates should be encouraged to participate in the wide range of research activities at M.I.T. The establishment of UROP was, in fact, the formalization and expansion of a long tradition of providing research opportunities for undergraduates (through senior thesis, and "special problem" subject numbers for example) that existed in several departments. The objectives of the program were to facilitate undergraduate research in departments where it was already happening and to help initiate opportunities where none previously existed.

From the first 125 UROP students who participated in fall, 1969, to the more than 2,000 students involved during 1974-75, student enthusiasm and faculty support have flourished. During the past year more than half of the faculty, from all 24 departments, collaborated with undergraduate colleagues on topics ranging from biomedical engineering to city planning, from presidential politics to water resources. UROP attracts students from every class, department, and background imaginable; roughly equal numbers of freshmen, sophomores, juniors, and seniors participate. The UROP experience includes all phases of research activity: proposal writing, finance procurement, design of the experiment or research scheme, conduct of the work analysis, presentation, and rewards.

As a vehicle for creating and promoting research opportunities for undergraduates, UROP strives to keep abreast of and reflect the overall research trends of the Institute. The program is designed to be sufficiently flexible to allow immediate response to faculty and student desires for change, expansion, or re-emphasis.
Undergraduate Research Opportunities Program

This academic year proved to be an active one for UROP, with approximately 200 additional undergraduates participating in the program. As an illustration, the Departments of Biology, Architecture, and Political Science nearly doubled their participation this year. Although most UROP students receive academic credit for their efforts, UROP central continued to provide support for wages, materials, and supplies for a limited number of students. In addition, there was a dramatic increase in faculty support of UROP student wages. Outside monetary support for undergraduate research was provided by grants to UROP from the Uniroyal Foundation, the MITRE Corporation (in Memory of James McCormack), the Society of Sigma Xi, M.I.T.'s Class of 1970 Class Gift, and the Clapp and Poliak Fund.

UROP is actively pursuing collaborations with M.I.T. academic departments and other academic programs in order to broaden the spectrum of departmental undergraduate opportunities. During the past year, UROP Symposia were held by the Departments of Physics, Nutrition and Food Science, and Chemistry. These symposia offer undergraduate researchers the chance to present their work and discuss their findings with faculty and other students in their departments. It is hoped that the next year will see more of these departmental forums for UROP students. In addition, UROP is currently planning two interdepartmental symposia for the 1975-76 school year, one in collaboration with the Society of Sigma Xi for students in the School of Engineering. UROP has also worked closely with the Departments of Political Science and Urban Studies and Planning on programs such as the Washington Internships, the Legislative Internship, and the Urban Legal Studies Program. A UROP contribution also helped finance the Student Summer Projects in Community Affairs.

Off-campus UROP, initiated in 1972 in response to student requests, offers research projects with approximately 100 organizations including industry, hospitals, government agencies, and museums. In 1974-75, approximately 300 students participated in the off-campus program, with the heaviest concentrations of student interest in computer technology and medically related areas. A burgeoning interest in government and legal studies was also apparent. During the past year, "site visits" to students doing off-campus projects were initiated. Site visits afford the UROP office valuable insights into the nature of off-campus projects.

After six years of existence, UROP seems to be coming of age in the Institute. The maturity of the program is vividly demonstrated by the increasing sophistication of students' work, partly a result of the trend toward longer range projects (two years or more). The number of inquiries to the UROP office by high school students considering M.I.T. has risen sharply. The number of students scheduling a UROP project into their four year plan as a complement to their formal classroom work is also on the rise. Perhaps the most striking evidence of UROP's growth is the accomplishments of the student participants. The past year has seen UROP students make major contributions to faculty research, present their work to professional conferences, publish their findings in major scientific journals, submit proposals to outside funding agencies (and receive funding!), prepare legislation, and win prizes.

During the year, Scott Matthews and LaVerne Smith left the Institute, and although it was difficult to replace them we have excellent new members in Stanley Hudson and Marie LeBlanc. Diane Michalik, Deborah Card, and Gregory Smith continue to make the Undergraduate Research Opportunities Program effective.

MARGARET L. A. MACVICAR
Detroit Institute of Technology-M.I.T. Association

Evolving from meetings in 1970 between personnel of the Detroit Institute of Technology (D.I.T.) and M.I.T., the D.I.T.-M.I.T. Association was established in 1971 "to improve and strengthen the academic program of D.I.T." The activities of the Association are funded by the Detroit Institute of Technology which receives partial support for M.I.T.'s involvement under a U.S. Department of Health, Education, and Welfare grant for strengthening developing institutions.

During the past year, ten M.I.T. faculty, staff, and outside consultants have assisted D.I.T. faculty and administrators in improving D.I.T.'s academic program. These personnel spent an average of 12 days per month working with their counterparts in Detroit. In addition to those involved on a continuing basis, a number of other M.I.T. personnel, including academic deans, administrators, faculty, and students have contributed to M.I.T.'s efforts on a more limited basis.

M.I.T.'s original involvement in developing the New Study Program at D.I.T. has expanded and broadened into other areas at the school. Institute personnel and consultants are involved in the areas of biology, chemistry, physics, mathematics, engineering (electrical and manufacturing), the social sciences, and business. Although the level and degree of interaction varies among these disciplines, the overall impact of M.I.T.'s activities at D.I.T. has been significant. There is a growing realization among D.I.T. faculty and administrators of the importance of commitment and need for leadership in the development of viable academic programs.

In addition to efforts in the academic area, M.I.T. has assisted D.I.T. in administrative matters. In July, 1974, M.I.T. was host to D.I.T.'s President, two Vice Presidents, and a member of D.I.T.'s Board of Trustees (who is also an M.I.T. alumnus). The D.I.T. contingent met with some of M.I.T.'s deans and faculty and spent time with staff from the Admissions Office, the Athletic Department, the Studio Arts Program, the Alumni Association, and Physical Plant. Despite a difficult economic situation in the Detroit area, D.I.T., through the assistance and efforts of the D.I.T.-M.I.T. Association, is coming to grips with the problems of developing an academic program which addresses the needs of Detroit's inner city students.

MARTHA S. DRAPER

Energy Laboratory

In the past year, the Energy Laboratory has greatly increased its visibility as the focal point for energy-related research at M.I.T. The second year of operation has seen clarification and organization of the various research areas. The grant funds awarded to the Laboratory during its first year have enabled it to embark on a program of definition which has led to increased contracts. The present annual budget for the Laboratory exceeds $4,000,000.

This year the Laboratory's increased activities have required new full-time staff, expanded facilities, administrative management, and faculty participation from other departments.
Energy Laboratory

As a special laboratory, the Energy Laboratory does not appoint faculty members. Thus the Laboratory's 45 technical staff members form only a portion of its manpower, supplemented by some 55 faculty members from ten different departments and all five schools. The number of students involved in the Laboratory's research activities has increased to 85, including graduate research assistants, fellowship students, and undergraduates. Administrative procedures are now handled by a full-time administrative officer, an accountant, and a personnel officer.

As the Laboratory has grown, the internal organization has changed and expanded to effectively manage and plan its programs. Four administrative units have been established, each with a full-time program director, selected faculty coordinators, and associated faculty and research staffs. These are: Special Programs; Energy Management and Economics; Nuclear, Environmental, and Electric Power; and Fossil Fuel. This dual structure of professional staff and faculty cooperating in the management of Laboratory programs is designed to keep research and academic programs closely coupled and to establish an efficient mechanism for operating interdisciplinary activities and interacting with user groups. It is anticipated that this basic structure will allow for expansion of the Laboratory's program by adding new administrative units or subdivisions as necessary. Management of facilities that may be required for larger scale prototypes or special research activities also can be effected through additional administrative units with an appropriate mix of professional staff, faculty, and students.

**Special Programs**

The Special Programs administrative unit establishes a mechanism for developing programs that are as yet not large enough for the establishment of a separate program area, or which do not fit into one of the other three program areas. This unit also coordinates the activities of the end use technology and alternate energy technology areas of technical concentration. The end use technology area is dispersed widely and involves many programs of research on processes and structures, primarily under study in the Schools of Engineering and Architecture and Planning. One current project is a solar-assisted space conditioning system for the Citicorp Center building in New York City for which the Laboratory is taking the lead responsibility in facility design, cost determination, and program evaluation. The alternate energy technology area draws heavily on research at Lincoln Laboratory performed cooperatively with the Energy Laboratory and the School of Engineering. Current programs broadly cover advanced materials research for electrochemical and solar energy conversion systems. The Special Programs unit is headed by Dr. James W. Meyers.

**Energy Management and Economics**

The Energy Management and Economics administrative unit concentrates its work on the development of analytical models of the energy sector, studies of specific policy issues and technical choices, and research on energy data and management information systems. Current projects stress supply-demand models for domestic natural gas and oil, electricity, world oil, and coal, and a model of the oil and gas discovery process. Additional work is under way on energy data management. This unit draws heavily upon the Departments of Economics and Political Science, the Alfred P. Sloan School of Management, and the
Vice President, Research

School of Engineering. The Energy Laboratory policy study group also works out of this unit. Drawing upon the Laboratory's professional staff and faculty from various departments, short-term responses to critical energy policy issues are undertaken. Initial efforts by this group resulted in "Energy Self-Sufficiency: An Economic Evaluation," published in Technology Review of May, 1974. In addition, current research is contributing to a National Science Foundation review of the Federal Energy Administration's "Project Independence Report," published in November, 1974. The policy study group exemplifies the ability of the Laboratory to draw together experts from inside M.I.T. and to couple these effectively with experts from other universities, industry, and government agencies. A successful conference entitled "United States Energy Policy, Analysis and Evaluation" was held in Houston in May, 1975. This conference was presented by the Energy Laboratory and included many members of the policy study group, who spoke to an audience of representatives from many Houston-area industries. The activities of the policy study group illustrate how interdisciplinary problems are managed internally and transferred to interested external organizations by the Laboratory. This unit is headed by David O. Wood, who joined the staff in January, 1975.

Nuclear, Environmental, and Electric Power

The Nuclear, Environmental, and Electric Power administrative unit organizes and conducts projects aimed at: 1) technical, environmental, and economic problems relating to development and utilization of nuclear power; 2) development of improved methods of prediction, monitoring, and control of environmental and health effects of energy production and utilization; and 3) development of improved electrical component design and improved methodology for planning, design, and operation of large interconnected systems. Nuclear technology projects that are now under way are directed toward development of improved methods of reactor safety, performance, and reliability analysis. Ongoing projects in the environmental technology area are aimed at development of an improved capability to control heat emissions to air and water from energy conversion activities and to assess their environmental impacts. Current electric power technology projects emphasize development of techniques and computer codes for system planning and operation with consideration of economic, engineering, and environmental aspects. Both ongoing and proposed projects draw upon the resources of M.I.T.'s Schools of Engineering and Science. Present projects are sponsored by various government and industry sources and the Institute itself. This unit is headed by Dr. William D. Hinkle who joined the staff in November, 1974.

Fossil Fuel

The Fossil Fuel administrative unit focuses on the many energy problems associated with fossil fuel technology. The program includes work on basic processes important in the various utilisations of fossil fuels, such as processing, conversion, combustion, separation, and cleaning of the emission products; the development of predictive models for basic processes, operating units, and systems related to electric power plants, boilers, processing plants, gas turbines, and automotive engines; and the determination of the scaling laws and of the engineering parameters that will guide the development of new systems and improvements of present systems. Current projects stress modeling and materials development for magnetohydrodynamics, combined cycle, fluidized bed, and advanced combustion systems, particularly emphasizing the clean combustion of coal. The projects draw heavily
upon the resources of the School of Engineering and involve extensive interaction with both mature and advanced technology industries. This unit is headed by Professor Jean F. Louis of the Department of Aeronautics and Astronautics who is taking a leave of absence from the Department while serving as program director.

During the past year, an advisory board of energy experts from outside M.I.T. was set up. This board reviews the work of the Laboratory on a periodic basis and brings a close working knowledge of energy problems to bear in advising the Laboratory on its current programs and future plans.

The Energy Laboratory has already successfully expanded the ranges of activities that could be undertaken fruitfully by the Institute. It has increased the opportunities available to students, and provided a mechanism for visiting professionals from industry to be involved in and to contribute to M.I.T.'s research programs. The Laboratory also has proved effective in the difficult area of managing interdisciplinary programs and may be a model for how such work can be administered. While the Laboratory's dissemination of quantitative data for public information has been limited, it has been significant, indicating that such communications are feasible if handled by knowledgeable and objective people. The Energy Laboratory looks forward to continued growth during the coming years as its programs become more well defined and the nation establishes its priorities on the important question of energy.

DAVID C. WHITE

Lincoln Laboratory

Several years of substantial, intensive effort in the development of Lincoln Experimental Satellites LES-8 and 9 are nearing completion, with a launch date scheduled for late fall, 1975. Meanwhile, a number of other Laboratory programs have yielded significant practical results in the course of the past year.

A dramatic improvement in the capability of airport surveillance radars to detect aircraft and to suppress ground-clutter, weather-clutter, and other spurious returns is made possible by a new digital signal processor that employs coherent linear filtering with automatic, adaptive thresholding techniques. Now being tested by the Federal Aviation Administration at its National Aviation Facilities Experimental Center (NAFEC) in New Jersey, this processor shows a 100-to-1 increase (over present processors) in the ability to detect aircraft in strong clutter when used with a conventional radar, only slightly modified. The processor's ability to suppress ground-clutter enables airport surveillance radars to be sited in (previously unacceptable) locations that will provide complete coverage of low-flying aircraft in the terminal area. It provides clear, consistent aircraft tracks through severe weather-clutter, "false alarms" produced by the weather-clutter are virtually eliminated, though the processor can also produce, if desired, a clear, well-defined map of weather disturbances within the radar coverage area. The experimental prototype processor being tested at NAFEC contains about 900 solid-state integrated circuits and occupies only two feet of relay-rack space.

Nearing completion and scheduled for initial operation this fall at White Sands, New Mexico, is a semi-automated experimental test system for optical detection and orbit determination of man-made satellites. Based on promising results from exploratory field tests conducted in 1972-73, this work is now part of the Air Force Ground Electro-Optical Deep Space
Surveillance Program (GEODDS). Using sensitive electro-optical image tubes with 14-inch and 31-inch telescopes, the test system will detect transient optical phenomena as faint as 16th or 17th magnitude, equivalent to conventional satellites at ranges somewhat beyond synchronous-orbit altitude, a valuable complement to current radar capabilities. In this connection, our Millstone Hill radar, which has been continually upgraded in performance since it first tracked Sputnik in 1957, is still providing valuable service to the Air Force in tracking particularly difficult targets.

Several related programs dealing with speech communication have come to a focus in the Digital Voice Terminal (DVT), a compact instrument for efficient full-duplex digital voice communication with reduced speech bandwidth. Using about 500 fast commercial logic and memory packages in a single five-inch rack-mounted unit or desk-top cabinet, the DVT includes audio processors, analog/digital converters, and digital modulation/demodulation facilities, plus a versatile high-speed digital processor for speech bandwidth compression and message formatting. Initially programmed to operate as a real-time linear predictive vocoder that preserves acceptable voice quality with a bandwidth reduction of approximately 20-to-1, the processor also has been programmed for several other modes of operation. Two DVT units have been completed and delivered for experimental tests at the Defense Communication Engineering Center in Reston, Virginia.

This report marks the conclusion of the long and illustrious career of our TX-2 computer. Since its inception in 1956 as one of the first large computers in which transistors supplanted vacuum tubes, TX-2 has consistently played a pioneering role in the evolution of computer technology and applications. It has been the vehicle for many significant research innovations in hardware, software, and computer architecture, especially in on-line applications and direct man-machine communication. In the process, it also has been an important vehicle for the intellectual development of many generations of students and scores of Lincoln staff members, past and present, including some of the leaders in contemporary computer research and engineering.

Capabilities developed in the course of our major programs have enabled us to undertake a number of small-scale exploratory efforts in selected areas. In the energy field, for example, we are carrying out studies of solar photoelectrolysis, the use of zeolites for solar cooling, solid electrolytes for high-energy-density batteries, the development of heat-mirrors for solar collectors, the use of tunable lasers for isotope separation, and the development of inexpensive thin-film silicon solar cells. Our principle programs continue to include communications, microwave and infrared radar, re-entry vehicle phenomenology, digital signal processing, electro-optics, air traffic control, and advanced electronics technology; these programs are continuing without any major changes in scope, scale, or sponsorship.

GERALD P. DINNEEN
Culminating nearly two years of intensive planning, on April 23, 1975, the five-year $225 million M.I.T. Leadership Campaign was announced publicly at a press conference in New York City. M.I.T. spokesmen were Chairman Howard W. Johnson, President Jerome B. Wiesner, Chancellor Paul E. Gray, and Paul F. Hellmuth, a member of the M.I.T. Corporation who is serving as co-chairman of the Campaign with Mr. Johnson. Thus formally began the greatest fund raising effort in the history of the Institute. Because preparation and planning for the Campaign have been the overwhelming concern of the Resource Development organization during the past year, the following report deviates somewhat from its traditional form. After a brief review of this year's gift data, the report presents basic information about the Campaign and summarizes highlights of the planning process and related organizational moves.

Private Support

Total private support of M.I.T. during the year was $21.7 million; this was made up of $20.3 million in gifts, grants, and bequests, and $1.4 million in other support through membership in corporate liaison programs described in detail below. This total compares with $22.7 million in 1974 and $21.7 million in 1973.

Sources of gifts for fiscal year 1975 were: alumni and alumni clubs, $6,204,842; non-alumni friends, $1,175,113; corporate foundations and trade associations, $5,504,352; foundations and charitable trusts, $7,368,105; and others, $29,969.

Among the major purposes for which gifts were designated by the donors in both endowed and expendable funds were: unrestricted, $3.8 million; departmental, $6.5 million; faculty salaries, $1.8 million; graduate scholarships and fellowships, $1.1 million; undergraduate scholarships, awards, and loan funds, $1.2 million; building construction funds, $4.6 million; and other funds, $1.3 million.

The M.I.T. Leadership Campaign

The coordination of all Campaign planning was carried out by the Institute's Council on Resources through which the emerging plans were presented to, reviewed by, and approved by the Corporation Development Committee and the Corporation.

Leadership

As already noted, Chairman Johnson and Mr. Hellmuth are co-chairmen of the Campaign. James B. Lampert, Vice President for Resource Development and director of the Campaign, will work closely with them in carrying it forward to success. Mr. Hellmuth, managing partner of Hale and Dorr, a Boston law firm, serves also with Mr. Johnson as co-chairman.
of the Campaign Steering Committee, whose other members, drawn from the Corporation, are: Paul M. Cook, ’47; Marshall B. Dalton, ’15; Luis A. Ferré, ’24; Cecil H. Green, ’23; Robert C. Gunness, ’34; J. Kenneth Jamieson, ’31; Breene M. Kerr, ’51; Paul V. Keyser, ’29; Ralph Landau, ’41; Carl M. Mueller, ’41; Clint W. Murchison, Jr., ’44; William B. Murphy; D. Reid Weedon, Jr., ’41; and John J. Wilson, ’29. Staff support for the Committee is provided by Nelson C. Lees.

Another key committee is the Campaign Leadership Committee, a large geographically-based group of volunteer community leaders who provide campaign leadership in their respective areas, including screening and identifying prospects, providing approaches to them, and participating as appropriate in solicitation. The members of this Committee as of the end of fiscal 1975 are: Hal L. Bemis, ’35; Earl A. Bimson, ’43; Paul M. Cook, ’47; Charles Diebold III, ’58; W.H. Krome George, ’40; Samuel A. Groves, ’34; Paul L. Hotte, ’42; J. Kenneth Jamieson, ’31; Breene M. Kerr, ’51; Charles B. McCoy, ’32; Robert E. E. Meyerhoff, ’44; William H. Mills, ’34; Joe F. Moore, ’52; E. Kirkbride Miller, Jr., ’41; Thornton W. Owen, ’26; John S. Reed, ’61; Wylie S. Robson, ’56; Charles H. Smith, Jr., ’42; Goff Smith, ’53; Robert B. Semple, ’32; William H. Schield, Jr., ’46; Sheridan C.F. Ing, ’45; Harold E. Thayer, ’34; Thomas R. Williams, ’54; D. Reid Weedon, Jr., ’41; Frank S. Wyle, ’41; Thornton A. Wilson, ’53; and Edward O. Vetter, ’42.

Goals

The principal thrust of the Campaign is to seek new endowment funds for M.I.T. A summary of the goals is noted below. The original timetable called for these goals to be accomplished in two parts: the first for $125 million as an initial three-year effort, and the second for $100 million in approximately the following two years. It is now our clear intention to carry out the Campaign as one extended effort over five years.

1) Endowment $100.0 million

Endowed funds for distinguished professorships and career development support for younger faculty; student aid, including loan funds, scholarship funds, and special loan subsidy support; research and innovation funds; and general endowment.

2) New Program Support $43.2 million

Expendable funds for new programs in the Energy Laboratory, health sciences, the Division for Study and Research in Education, creative and performing arts, library system development, continuing education, and special school and departmental support.

3) Facilities $61.8 million

Carefully evaluated new facilities and renovations for student housing, athletics, the School of Management, the School of Architecture and Planning, the Department of Mathematics, the Department of Psychology, Lecture Hall, creative arts and public events, and the Independent Residence Development Fund.
Vice President, Resource Development

4) Unrestricted Funds $20.0 million

Unrestricted funds to allow critical flexibility in budgetary allocations, in permitting M.I.T. to respond without delay to immediate or short-term capital needs, and to permit the application of resources to purposes of maximum future benefit.

Grand Total Over Five Years $225.0 million

Announcement

On April 22, the day before the formal press conference in New York, plans for the Campaign were announced in Cambridge at a special luncheon for key alumni and friends at the President's House and at a special meeting of the Alumni Advisory Council that evening. Following the press conference in New York, a series of luncheons and one dinner for industrial and community leaders were held over the next eight days in New York, Philadelphia, Pittsburgh, Los Angeles, San Francisco, Chicago, Dallas, and Oklahoma City; a leading alumnus or friend was host at each. Chairman Johnson, President Wiesner, Mr. Hellmuth, and several other senior officers participated in each. Special meetings were held at M.I.T. to brief members of the faculty and student leaders. In addition, the news release announcing the Campaign was mailed to all alumni and many key friends, foundations, and corporations.

Basic Campaign Strategy

The M.I.T. Leadership Campaign seeks commitments on the order of $10,000 and more over five years from alumni, friends, foundations, and corporations. Close coordination with the Alumni Fund will insure that all alumni are reached. The Fund effort will continue throughout the Campaign with increased dollar and donor goals. All gifts and pledges to M.I.T. during the Campaign period, including gifts through the Alumni Fund, will be counted towards the Campaign. A nucleus fund of approximately $43 million was announced on April 23, and it represented all gifts and pledges to M.I.T. since January 1, 1974.

Resource Planning

Principal responsibility in the Resource Development organization for providing staff support during the planning of the Campaign was carried by Mr. Lees, Director of Resource Planning, and his group comprising the Development Office, Donor Relations, Proposals and Publications, the Campaign Room or information center, and the Resource/Alumni Data Systems (R/ADS) group. The latter is a special computer group established early in fiscal 1975 under Victor M. Maslov to provide computer support during the Campaign in conjunction with O.A.I.S. and I.P.C. to Resource Development, the Alumni Association, the Alumni Fund, and Technology Review; Robert M. Matson and Merry F. Peterson joined R/ADS early in the year. The Development Office under the direction of James W. Lambert, continued its central role of evaluating more than 1,200 prospects during the year and preparing backup for approximately 100 visits by senior officers and others. Donald B. Johnson and Michael F. Luck joined the Office as assistant directors and Charles F. Fenno resigned. The resignation of Mr. Lambert at the end of the year to accept a position at another university was a source of regret. A large number of publications supporting the Campaign were developed during the year by the Proposals and Publications group -- Joseph G. Carr,
Joyce Bowden, Deborah J. Cohen, and Michael K. Hubner. They also produced a number of major proposals supporting solicitations by senior officers. The Campaign Room became operational late in the year under Jurate J. Barnes, for whom this meant new responsibilities.

In Donor Relations, Barbara V. Zeilenga continued to prepare drafts of several hundred acknowledgments to donors of $500 or more to be signed by the President and other senior officers.

Other major R/ADS efforts included the development of the on-line time-share Central Prospect Control System in the Campaign Room to coordinate and control Campaign solicitation activity; among the total of 198 jobs that were completed by R/ADS were key efforts on the Alumni Register Questionnaire, and Project Synergy that compiled development data on 2,500 major donors and key prospects.

Resource Operations

All of the complex arrangements and staging of Campaign announcement luncheons were carried out under the direction of Kenneth S. Brock, Director of Resource Operations. In these tasks he was supported by Project Officer James T. King. In addition to supporting the activities of the Corporation Development Committee, briefly reported below, Mr. Brock's primary effort during the year was the development of the Campaign Leadership Committee. Recommendations for members in cities across the country were made; chairmen were recruited; Mr. Brock, with Donald P. Severance, Director of the Volunteer Leadership Appeal, visited or arranged to visit 22 cities by the end of the year. Concurrently, five staff personnel were recruited by Mr. Brock to serve as district officers, and by June 30, all were hired except the officer for the Boston/New England area.

Particular note should be made of the complexity of the task that Mr. Brock and Mr. Severance have taken on. It involves organizing of key volunteers throughout the country to support the many needs of the Campaign, maintaining the volunteers' enthusiasm, and securing extensive required commitments of time from them. Throughout this organizational period, one fact has been preeminent; the enthusiastic willingness of volunteers to accept and discharge assignments. This energy and loyalty represent voluntarism at its finest and presage success for the Campaign.

Organization

The Council on Resources of the Institute, comprising the Chairman of the Corporation, the President, the Honorary Chairman of the Corporation, the Chancellor, the Provost, the Treasurer, and the Vice President for Resource Development, was expanded to include Mr. Hellmuth, co-chairman of the Campaign, and James A. Champy, Executive Vice President of the Alumni Association. The Council continues to play a vital part to coordinate planning, establish priorities, and provide a concentrated focus on financing the present and the future. As was the case with Resource Development's staff, much of the Council's time continued to be devoted to Campaign planning, as well as to the overall direction of ongoing fundraising activities. Mr. Lees serves as Secretary of the Council.

As in 1973, the Corporation Development Committee met the day before the December meeting of the M.I.T. Corporation. The day-long meeting culminated in dinner, with remarks and reminiscences by the Committee's founder, James R. Killian, Jr., and President Emeritus Julius A. Stratton. Again this year, there were two issues of the
committee newsletter and extensive staff visits to members. Particularly warming is the large representation from the Committee in leading roles in the Campaign. During the past year the Committee lost through death the services of the following devoted members: David W. Skinner, William W. Garth, Jr., and General James McCormack.

Mr. Severance, '38, joined the Resource Development organization as Director of the Volunteer Leadership Appeal. He will work with the Director of Resource Operations on the creation of a geographical campaign organization, the identification and evaluation of leadership prospects, and will work closely with volunteers in solicitations. Coming to this post from a long and successful tenure as Executive Vice President of the Alumni Association, he offers a unique combination of personal ability and knowledge of M.I.T. alumni.

During the year increased efforts were made to insure closer coordination, formal and informal, between the Alumni Association and the Resource Development organization. The two activities closely complement one another and they need to act in close concert, both for efficiency and out of respect for the time of those alumni who assist each. Regular meetings attended by senior management from each office are conducted to promote this coordination, and informal cooperation and exchange of information are standard practice.

M.I.T. is in its second year of membership of the Committee for Corporate Support of Private Universities (CCSPU), a group whose members include selected universities involved in alerting industry to the need of giving strong support to leadership schools. Although several years old, the CCSPU has recently begun to reassess its role and its future. Mr. Brock represents M.I.T. on the Committee.

**Individual Giving**

Individual giving for the year was $7,379,955 in gifts, grants, and bequests from alumni and friends. D. Hugh Darden and Allan S. Bufferd in the office of the Institute Estate Secretary carried out a series of mailings to 22,000 alumni in post twenty-fifth reunion classes, bringing the number of known plans for future gifts to a total of 949 and effectively increasing the potential of Class Estate Secretaries.

During the year Institute policies with respect to a comprehensive program to aggressively seek and solicit gifts in trust with reserved life interests were defined. Necessary instruments, descriptive booklets, and related materials were completed and put in final preparation for use in such a program.

Contacts with donors and potential donors have continued on a selective and qualitative basis, and a number of current gifts as well as detailed plans for future gifts have been worked out in consultation with donors and their advisors. Prospects for the coming year should be enhanced by an expanded program to solicit gifts in trust within the context of individually planned programs of giving.

Messrs. Darden and Bufferd gave continuing attention during the year to the area of possible Federal tax reform which might affect charitable giving. In addition, there has been substantial Federal activity especially in the Internal Revenue Service related to new rules and regulations which might affect unfavorably the operation of colleges and universities. All these matters have been followed closely to assure an appropriate and effective Institute input. The year also has been marked by substantial activity in providing counsel and support on a wide variety of legal matters affecting Resource Development.
The retirement at the end of the year of Malcolm G. Kispert, Institute Secretary, closed a distinguished career of service to M.I.T. Over the past four years Mr. Kispert has concentrated his activities on contacts with individual prospects with larger giving potential.

Foundations and Charitable Trusts

The new legal requirements affecting foundations and charitable trusts introduced some uncertainties into this support. During the year, 132 foundations and charitable trusts made 218 gifts and grants to M.I.T. totalling $7,368,105. This represents 34 percent of the $21.7 million received by M.I.T. as gifts, grants, and bequests and through other corporate support representing Industrial Liaison and Associates Program memberships. This compares with total support from foundations and charitable trusts of $9,098,888 in 1974 and $6,564,055 in 1973.

Corporations

The effect of the general economic climate was reflected in the support to M.I.T. provided by corporations, both in grants and in other support through membership in the Industrial Liaison Program and Associates Program reported separately below. Corporate support for the year was $5,504,352; this compares with $7,316,185 in 1974 and $7,332,416 in 1973. Institute Secretary C. Warren Smalzel took on as a full time assignment during the year activity in support of the M.I.T. Energy Laboratory to give funding of this top priority objective further momentum. Institute Secretary Robert Hagopian continued seeking new members for the Industrial Liaison Program, with special stress on encouraging visits to M.I.T. by company representatives as a marketing procedure.

The Resource Development organization assisted with coordination of two dedication ceremonies during the year. Paul H. Burr organized the dedication ceremony for the Seeley G. Mudd Building, housing the Center for Cancer Research, and Mr. King coordinated the ceremony for the George R. Wallace, Jr., Geophysical Laboratory at Westford.

Industrial Liaison

I am pleased to record the appointment, early in the year, of Professor Samuel A. Goldblith, Underwood-Prescott Professor of Food Science, as Director of Industrial Liaison. One of M.I.T.'s most distinguished professors, Professor Goldblith has provided dynamic leadership for the Industrial Liaison Program while continuing, part-time, his academic and related professional activities.

The Industrial Liaison Program has undergone considerable change during the past year in an effort to revitalize it, to assist M.I.T. in becoming closer in its relationship to industry, to become more international in scope, and to be a vital cog in the new capital campaign of the Institute.

In meeting each of the above objectives, the need for close and active cooperation from the members of the faculty has been of vital importance. The faculty has been extremely cooperative in assisting the program to meet its objectives, by active participation in solicitation visits of prospective member companies both at M.I.T. and at the companies' respective headquarters, in research briefings at M.I.T., organization of and participation in symposia.
and seminars, the preparation of the Industrial Liaison Program Directory of Current Research, and enlarged Monthly List of Publications and in providing better quality service to member companies by faculty visitations. To the faculty, the Industrial Liaison Program owes a debt of thanks. In addition, the senior officers of the Institute have been most generous of their time on behalf of the Program.

Highlights of some of the developments which have occurred and which should prove to be of particular importance in the next several years in achieving the prime goals of the Program include:

1) Increasing M.I.T.'s ties to industry;
2) Participation in and drawing from the intellectual life of the Institute;
3) Increasing the number of member companies significantly and thus providing more General Funds for the Institute;
4) Improving and increasing the quality of service to the member companies; and
5) Assisting the Institute in its new, major Capital Campaign drive for funds.

With the success of the revenue-sharing plan which provides for the professional development of the participating faculty members, a new revenue-sharing plan for assistance in identifying, soliciting, and bringing in new member companies has been approved effective July 1, 1975.

Industrial Liaison Program symposia and seminars are now being taped and the tapes (and vuegraphs) are being made available to member companies. This new service has been well received, particularly by our member companies from abroad and our multinational companies. Also, in a time of budget pressures, with restricted travel of company personnel, these tapes have been useful to U.S. companies in making these symposia valuable to more technical and management personnel than those who attend the symposia/seminars.

Faculty travel to member companies for seminars and discussions with management and technical personnel has continued to be of tremendous value in maintaining close and effective liaison with member companies.

Liaison with the Alumni Association has been continued and expanded through presentation of seminars and symposia under Association sponsorship for Industrial Liaison Program members and prospective members.

Joint sponsorship of symposia under the Industrial Liaison Program/M.I.T. Sea Grant Program also has proven to be effective.

Efforts are being made to work more closely with the Center for Advanced Engineering Studies. Plans are being considered for the development of short subjects in science, engineering and management which would be of interest to member companies.

Special application forms for Industrial Liaison Program company members for M.I.T. Summer Session programs have been initiated, and informal social gatherings were held for Summer Session attendees from Industrial Liaison Program member companies. This has enabled us to give these individuals an opportunity to learn about the Program and its opportunities for interfacing with M.I.T.
In an effort to increase Program membership over the past two years, special symposia preceded by a dinner for the senior officers of companies in the food and in the pharmaceutical industry have been held.

As part of the company membership solicitation effort and to service better our European member companies, two special one-week programs are being planned for European member company personnel and for prospective personnel. These programs will take place in January, 1976, in Zurich, Switzerland.

Two new Liaison Officers were added to the staff this year: Cynthia Bloomquist, formerly Assistant Director of Admissions; and Henry Barg, an alumnus of the Sloan School. These are replacements for Mr. Jedlinsky and Ms. Hirsch who resigned.

Solicitation of potential new members is now one of the important tasks of the Liaison Officers, and it has proven to be effective in bringing in several new member companies.

Thus, the Program is striving to meet the objectives outlined earlier. To this end, I wish to express our deep appreciation to the Faculty Committee on Industrial Liaison as we strive to grow rapidly to become part of the intellectual life of the Institute.

M.I.T. Associates Program

Fiscal year 1974-75 might be best described as a year of mixed results and emerging, planned change for the M.I.T. Associates.

Under the direction of Jerome J. Schaufeld a detailed plan for growth was initiated and implemented during fall, 1974. This led to significant changes in our staff. First, Jordan D. Carter terminated his responsibilities as Assistant Director. Subsequent to this, David W. Dove and Thomas R. Henneberry were appointed Assistant Directors.

During the early months of 1975, priority was placed on a) establishing internal responsibilities within the existing group of companies, and b) seeking new participants for the Program. In this area the results were very impressive. A total of 130 solicitation companies were contacted during the first six months of 1975. From this group, 93 companies indicated interest in further discussion. This resulted in 25 proposals of which six new companies elected to participate. Unfortunately, this effort commenced during the most severe external economic environment that this Program has faced in recent years. On the other side, 13 companies terminated their participation. Of the ones that have withdrawn, several were honorary or had completed multi-year agreements.

In addition, internal efforts were directed to the analysis and understanding of a company's basis for participation. Intensive solicitation efforts of this and the past year have produced a preliminary base for this study.

In the area of the Program's services, the Revenue Sharing Plan appears to have provided an incentive for more interaction with the faculty. During the past year the number of visits to faculty by existing and solicitation companies increased from 76 to 151.

Secondly, the response to the Round Table Discussions that were initiated two years ago has increased significantly. The total number of people attending the four sessions increased from 45 to 82. This year the Associates Program sponsored four Round Table discussions which included:
1) "The Current Economic Crisis and the Immediate and Short-Term Business Implications." Speaker: Professor Lester C. Thurow. October 9, 1974.


A third effort by the Program's staff included a January presentation at the New York City Alumni Club's Venture Clinic. This presentation provided an interesting exchange of data between the participants of the clinic and our staff. In addition, it provided the basis for preliminary discussion for an Associates Program Venture Clinic which may be established in fall, 1975.

In meeting its responsibilities, which are of very large importance to M.I.T.'s future, the Resource Development organization is motivated and guided by a deep conviction, shared by those who lead the Institute, that giving produces continuing institutional responsibilities to the donor. In the fullest sense, M.I.T. and each benefactor enter into a continuing relationship which should produce continuing satisfaction and shared experience. We regard the cultivation of each such relationship as a major part of our duty.

JAMES B. LAMPERT
Treasurer of the Corporation

Operations

Total operations in 1974-75 were $237,149,000, up from $224,352,000 in 1973-74, an increase of 6 percent. The higher level of operating expenses in 1974-75 over 1973-74 reflected primarily the increase in staff salaries and employee wages and related benefits, this element of expense being the largest component of total operating expenses. Administration, fiscal and general expenses in 1974-75 included some additional services expenses. The continuing rise in plant operations and maintenance expenses was due to the upward trend in energy costs and the expanded educational plant of the Institute.

Total unrestricted resources of $4,596,000 were required to meet the operating expenses of the year 1974-75 compared with $5,309,000 in 1973-74. Within the total of $4,596,000 is included $4,116,000 of general unrestricted resources and $480,000 from the Research Reserve. In 1973-74, $2,528,000 of general unrestricted resources and $2,781,000 from the Research Reserve made up the total unrestricted resources of $5,309,000 used for operations. The application of the Reserve reflected partially the financial effect in 1974-75 and 1973-74 of the reduced level of sponsored research resulting from the divestment of the Charles Stark Draper Laboratory.

Gifts

Gifts, grants and bequests received in 1974-75 and in 1973-74 were as follows:

<table>
<thead>
<tr>
<th>1974-75</th>
<th>1973-74</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gifts for endowment</td>
<td>$3,633,000</td>
</tr>
<tr>
<td>Gifts for buildings</td>
<td>4,703,000</td>
</tr>
<tr>
<td>Gifts for current use—invested</td>
<td>4,259,000</td>
</tr>
<tr>
<td>Other funds for current use</td>
<td>4,187,000</td>
</tr>
<tr>
<td>Total gifts to funds</td>
<td>$16,782,000</td>
</tr>
<tr>
<td>Grants-in-aid</td>
<td>3,500,000</td>
</tr>
<tr>
<td>Total</td>
<td>$20,282,000</td>
</tr>
</tbody>
</table>

Additions to the endowment for professorships, for fellowships, scholarships and for research support were received in 1974-75. Capital gifts and grants for buildings included funds for the Chemical Engineering Building, for The Seeley G. Mudd Building for cancer research and other related medical research activities, for the Sherman Fairchild Building, for The George R. Wallace Geophysical Observatory, and a bequest to complete the funding of the James M. Barker Engineering Library. The bequest of Vannevar Bush of $861,000 was received in 1974-75. The support of academic departmental programs is included within the Gifts for current use-invested. Unrestricted gifts of $2,173,000 included bequests of $1,595,000 to the Institute. Gifts reported by the Alumni Fund for 1974-75 were $3,327,000.
Treasurer of the Corporation

Funds

The book value of the funds was $344,907,000 on June 30, 1975 compared to $343,964,000 on June 30, 1974.

<table>
<thead>
<tr>
<th></th>
<th>1974-75</th>
<th>1973-74</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endowment funds:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For general purposes</td>
<td>$76,351,000</td>
<td>$76,067,000</td>
</tr>
<tr>
<td>For designated purposes</td>
<td>121,754,000</td>
<td>117,832,000</td>
</tr>
<tr>
<td>Net realized gains from investments</td>
<td>41,143,000</td>
<td>40,652,000</td>
</tr>
<tr>
<td>Total endowment funds</td>
<td>$239,248,000</td>
<td>$234,551,000</td>
</tr>
<tr>
<td>Building and expendable funds</td>
<td>62,030,000</td>
<td>66,131,000</td>
</tr>
<tr>
<td>Other funds</td>
<td>43,629,000</td>
<td>43,282,000</td>
</tr>
<tr>
<td>Total funds</td>
<td>$344,907,000</td>
<td>$343,964,000</td>
</tr>
</tbody>
</table>

The increase in endowment funds for designated purposes of $3,922,000 was provided largely from gifts and bequests for professorships, fellowships, scholarships and research support.

The decrease in 1974-75 in Building and Expendable Funds of $4,101,000 was due largely to the appropriation of funds to meet the cost of additions to educational plant not otherwise funded, to fund advances of resources that were not recovered, and the use of funds accumulated in earlier years for operations.

In 1974-75, net new patent resources of $431,000, $1,351,000 for allowances for use of facilities for sponsored research, and gifts and bequests of $2,173,000 provided additional unrestricted resources of $3,955,000. In 1973-74, unrestricted resources from the same sources were $3,173,000. During 1974-75, all of the patent resources and the allowances for the use of facilities were used in meeting operating expenses, and $1,312,000 of the unrestricted gifts and bequests of $2,173,000 for the year were used for operating expenses, so that unallocated unrestricted funds at June 30, 1975 were $361,000. $4,596,000 of unrestricted resources were allocated in 1974-75 to operating expenses, and additional unallocated unrestricted resources of $3,689,000 were used to fund the special charges set out in detail in Schedule E of this report.

The appropriations of unrestricted funds for operations, for student aid, and for other special charges in 1974-75 were $8,285,000 compared with $8,636,000 in 1973-74 and $2,674,000 in 1972-73.

The unallocated investment income for distribution to funds was $19,987,000 on June 30, 1975 and $21,325,000 on June 30, 1974.

During the year, the reserve established in 1972-73 and 1973-74 of $739,000 to meet the unrecoverable and other construction costs of the turnkey housing projects for the elderly in Cambridge was partially expended, leaving $116,000 which is expected to be adequate to complete the projects.
Treasurer of the Corporation

Plant

The major additions to educational plant in 1974-75 were The Seeley G. Mudd Building and the Avery Allen Ashdown Graduate House modernization, bringing the book value of the plant at June 30, 1975 to $197,513,000 up from $190,029,000 on June 30, 1974. Funding of the major building construction commitments of the Institute is completed with the exception of the new undergraduate house where total funding is yet to be secured.

The total mortgage indebtedness of $26,892,000 consists of $10,825,000 of Federal government loans and $16,267,000 of other loans on June 30, 1975.

Investments

The year-to-year change in the endowment and other investments is shown in the following table:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>General investments</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed income</td>
<td>$146,272,000</td>
<td>$125,961,000</td>
<td>$151,863,000</td>
<td>$127,769,000</td>
</tr>
<tr>
<td>Equities</td>
<td>107,968,000</td>
<td>189,384,000</td>
<td>107,169,000</td>
<td>177,360,000</td>
</tr>
<tr>
<td>Real estate for present or future Institute use</td>
<td>12,777,000</td>
<td>12,777,000^1</td>
<td>12,990,000</td>
<td>12,990,000^1</td>
</tr>
<tr>
<td>Other real estate</td>
<td>28,978,000</td>
<td>30,690,000^2</td>
<td>28,863,000</td>
<td>31,024,000^2</td>
</tr>
<tr>
<td>Due from Educational plant funds</td>
<td>7,199,000</td>
<td>7,199,000</td>
<td>5,628,000</td>
<td>5,628,000</td>
</tr>
<tr>
<td>Total</td>
<td>$303,194,000</td>
<td>$366,011,000</td>
<td>$306,513,000</td>
<td>$354,771,000</td>
</tr>
<tr>
<td>Separately invested</td>
<td>17,629,000</td>
<td>17,249,000</td>
<td>17,436,000</td>
<td>16,488,000</td>
</tr>
<tr>
<td>Students' notes receivable</td>
<td>19,215,000</td>
<td>19,215,000</td>
<td>16,917,000</td>
<td>16,917,000</td>
</tr>
<tr>
<td>Total</td>
<td>$340,038,000</td>
<td>$402,475,000</td>
<td>$340,866,000</td>
<td>$388,176,000</td>
</tr>
</tbody>
</table>

1 At cost
2 At values determined by professional appraisers
3 Net of reserve

The increase of $14,299,000 in the market value of the portfolio in 1974-75 was due to the higher market value of the common stocks and the fixed income securities at the end of the year and compares with a decline in market value in 1973-74 of $52,748,000. The market value of the total portfolio was $402,475,000 on June 30, 1975, $388,176,000 on June 30, 1974, and $440,924,000 on June 30, 1973.
Total investment income received during the year was $18,761,000 compared with $19,399,000 in 1973-74. After the deduction of administrative expenses, there remained $18,332,000 of investment income for operating expenses and other purposes.

The investment income distributed to funds was in excess of the net investment income earned and available for operating and other expenses, so that $1,338,000 was appropriated from the unallocated investment income reserve. In contrast to the reduction in this reserve in 1974-75, $177,000 was added to it in 1973-74, $582,000 in 1972-73, and $294,000 in 1971-72. The Reserve of Unallocated Investment Income that has been accumulating continuously since 1950 was drawn down for the first time in 1974-75.

Retirement Funds

The retirement plan investments in the following table are not part of the financial assets of M.I.T.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pension Association</td>
<td>$80,194,000</td>
<td>$77,226,000</td>
<td>$75,599,000</td>
<td>$68,649,000</td>
</tr>
<tr>
<td>Supplementary Retirement Plan-Fixed Benefit</td>
<td>42,978,000</td>
<td>39,209,000</td>
<td>40,360,000</td>
<td>35,041,000</td>
</tr>
<tr>
<td>Retirement Plan-Variable Fund</td>
<td>22,715,000</td>
<td>23,259,000</td>
<td>21,334,000</td>
<td>19,703,000</td>
</tr>
<tr>
<td>Retirement Plan for Employees</td>
<td>42,472,000</td>
<td>38,203,000</td>
<td>41,123,000</td>
<td>34,990,000</td>
</tr>
<tr>
<td>Total</td>
<td>$188,359,000</td>
<td>$177,897,000</td>
<td>$178,416,000</td>
<td>$158,383,000</td>
</tr>
</tbody>
</table>

The retirement plan investments are supplemented by reserves of approximately $6,400,000 held by a life insurance company to provide specified benefits under the Retirement Plan for Employees. $7,331,000 of M.I.T. pension contributions were a part of Institute operating expenses in 1974-75, and $7,529,000 in 1973-74. As of June 30, 1975, unfunded past service costs of $2,300,000 of the Retirement Plan for Employees were being amortized over twelve years.

The investments of the Pension Association and the Supplementary Retirement Plan-Fixed taken together at market values on June 30, 1975 were 2 percent in short-term investments, 67 percent in fixed income securities, and 31 percent in equities. The Retirement Plan for Employees was 4 percent in short-term investments, 63 percent in fixed income securities, and 33 percent in equities. The Retirement Plan Variable Fund was invested 9 percent in short-term fixed-rate investments and 91 percent in equities on June 30, 1975.
General

The increase in endowment funds in 1974-75 adds to the strength and capability of the Institute to meet its responsibilities in education and research over the long term. The reduction in expendable accumulated funds for operating expenses should be offset in future years as the Leadership Campaign makes further progress toward the established goals. The substantial appropriations of unrestricted funds for special charges in 1973-74 and in 1974-75 in some measure were related to requirements that may be reduced in succeeding years, so that these resources of the Institute may be conserved or increased for the future and thereby accrue to support the financial stability of M.I.T. in the years ahead.

JOSEPH J. SNYDER
SOURCES OF REVENUE AND FUNDS USED
TO MEET EXPENSES OF CURRENT OPERATIONS
FOR THE YEARS ENDED JUNE 30, 1975 AND 1974

Schedule A

<table>
<thead>
<tr>
<th>OPERATING EXPENSES</th>
<th>1975</th>
<th>1974</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruction and unsponsored research</td>
<td>$37,591,000</td>
<td>$33,711,000</td>
</tr>
<tr>
<td>Sponsored research (Note A):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Departmental and interdepartmental</td>
<td>64,992,000</td>
<td>59,436,000</td>
</tr>
<tr>
<td>Lincoln Laboratory</td>
<td>72,922,000</td>
<td>70,775,000</td>
</tr>
<tr>
<td>Draper Laboratory</td>
<td>1,162,000</td>
<td>6,214,000</td>
</tr>
<tr>
<td>Research vacation expense</td>
<td>3,748,000</td>
<td>3,555,000</td>
</tr>
<tr>
<td>Research administration and general expenses</td>
<td>1,465,000</td>
<td>1,410,000</td>
</tr>
<tr>
<td>Total expenses directly attributable to instruction and research</td>
<td>$181,880,000</td>
<td>$175,101,000</td>
</tr>
<tr>
<td>Costs applicable to both instruction and research:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Libraries</td>
<td>3,089,000</td>
<td>2,731,000</td>
</tr>
<tr>
<td>Medical</td>
<td>3,186,000</td>
<td>2,727,000</td>
</tr>
<tr>
<td>Plant operation and maintenance</td>
<td>15,134,000</td>
<td>13,505,000</td>
</tr>
<tr>
<td>Administration</td>
<td>4,140,000</td>
<td>3,334,000</td>
</tr>
<tr>
<td>Fiscal, personnel &amp; other Institute-wide services</td>
<td>8,786,000</td>
<td>7,816,000</td>
</tr>
<tr>
<td>General expenses</td>
<td>3,814,000</td>
<td>2,910,000</td>
</tr>
<tr>
<td>Other instruction and research support activities</td>
<td>1,862,000</td>
<td>1,775,000</td>
</tr>
<tr>
<td>Student services</td>
<td>5,438,000</td>
<td>5,181,000</td>
</tr>
<tr>
<td>Auxiliary activities</td>
<td>9,800,000</td>
<td>9,272,000</td>
</tr>
<tr>
<td><strong>Total costs applicable to instruction and research</strong></td>
<td><strong>$237,149,000</strong></td>
<td><strong>$224,352,000</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>REVENUES AND FUNDS USED</th>
<th>1975</th>
<th>1974</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuition and other income</td>
<td>$29,950,000</td>
<td>$27,004,000</td>
</tr>
<tr>
<td>Research revenues:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Departmental and interdepartmental</td>
<td>86,547,000</td>
<td>77,887,000</td>
</tr>
<tr>
<td>Lincoln Laboratory</td>
<td>81,895,000</td>
<td>76,637,000</td>
</tr>
<tr>
<td>Draper Laboratory</td>
<td>1,314,000</td>
<td>5,848,000</td>
</tr>
<tr>
<td>Appropriation of indirect expense allowance for use of facilities</td>
<td>(1,465,000)</td>
<td>(1,334,000)</td>
</tr>
<tr>
<td>Auxiliary activities</td>
<td>9,800,000</td>
<td>9,272,000</td>
</tr>
<tr>
<td><strong>Total research revenues</strong></td>
<td><strong>$237,149,000</strong></td>
<td><strong>$224,352,000</strong></td>
</tr>
<tr>
<td>Distributed to building and other invested funds</td>
<td>(1,976,000)</td>
<td>(3,793,000)</td>
</tr>
<tr>
<td>Distributed to endowment funds</td>
<td>16,356,000</td>
<td>15,306,000</td>
</tr>
<tr>
<td>Used for scholarships and fellowships</td>
<td>(2,577,000)</td>
<td>(2,187,000)</td>
</tr>
<tr>
<td>Added to unexpended balances and transferred to other funds</td>
<td>(3,273,000)</td>
<td>(3,438,000)</td>
</tr>
<tr>
<td>Used for operations</td>
<td>10,506,000</td>
<td>9,681,000</td>
</tr>
<tr>
<td>Gifts, investment income, and other receipts for designated purposes</td>
<td>14,006,000</td>
<td>12,048,000</td>
</tr>
<tr>
<td>Unrestricted funds used to meet operating expenses:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total need for unrestricted (Schedule E)</td>
<td>8,285,000</td>
<td>8,636,000</td>
</tr>
<tr>
<td>Transfers and appropriations (Schedule E)</td>
<td>(3,689,000)</td>
<td>(3,327,000)</td>
</tr>
<tr>
<td><strong>Used for operations (Schedule E)</strong></td>
<td><strong>$237,149,000</strong></td>
<td><strong>$224,352,000</strong></td>
</tr>
</tbody>
</table>

The accompanying notes are an integral part of the financial statements.
Treasurer of the Corporation

BALANCE SHEETS JUNE 30, 1975 AND 1974

Schedule B

ASSETS

CURRENT FUND ASSETS

<table>
<thead>
<tr>
<th></th>
<th>1975</th>
<th>1974</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General purposes</td>
<td>$399,000</td>
<td>$189,000</td>
</tr>
<tr>
<td>Restricted, principally to research activities</td>
<td>8,346,000</td>
<td>8,042,000</td>
</tr>
<tr>
<td>Accounts receivable:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S. Government</td>
<td>2,326,000</td>
<td>4,512,000</td>
</tr>
<tr>
<td>Other</td>
<td>6,118,000</td>
<td>6,039,000</td>
</tr>
<tr>
<td>Contracts in progress, principally U.S. Government</td>
<td>10,566,000</td>
<td>9,805,000</td>
</tr>
<tr>
<td>Deferred charges, inventories and other assets</td>
<td>11,925,000</td>
<td>14,587,000</td>
</tr>
<tr>
<td>Due from invested funds (short term)</td>
<td>4,086,000</td>
<td>4,052,000</td>
</tr>
<tr>
<td></td>
<td>$43,766,000</td>
<td>$47,226,000</td>
</tr>
</tbody>
</table>

INVESTMENTS (Notes B and D)

General investments, at cost:

<table>
<thead>
<tr>
<th></th>
<th>1975</th>
<th>1974</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed income</td>
<td>$146,272,000</td>
<td>$151,863,000</td>
</tr>
<tr>
<td>Equities</td>
<td>107,968,000</td>
<td>107,169,000</td>
</tr>
<tr>
<td>Real estate (including $12,777,000 – 1975 and $12,990,000 – 1974 for present or future Institute use)</td>
<td>41,755,000</td>
<td>41,853,000</td>
</tr>
<tr>
<td>Due from Educational Plant Funds</td>
<td>7,199,000</td>
<td>5,628,000</td>
</tr>
<tr>
<td></td>
<td>$303,194,000</td>
<td>$306,513,000</td>
</tr>
</tbody>
</table>

Investments of separately invested funds at cost | 17,629,000 | 17,436,000 |
Students' notes receivable | 19,215,000 | 16,917,000 |

Total investments | $340,038,000 | $340,866,000 |
Cash held for investment | 756,000 | 1,546,000 |
Receivables (Payables) arising from investment transactions | 686,000 | (2,127,000) |
Due (to) current funds | (4,086,000) | (4,052,000) |

|                      |        |        |
|                      | $337,394,000 | $336,233,000 |

EDUCATIONAL PLANT (Note A)

<table>
<thead>
<tr>
<th></th>
<th>1975</th>
<th>1974</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land, buildings and equipment, at cost</td>
<td>$178,971,000</td>
<td>$168,899,000</td>
</tr>
<tr>
<td>Construction in progress</td>
<td>17,101,000</td>
<td>14,209,000</td>
</tr>
<tr>
<td>Temporary investments and cash</td>
<td>1,441,000</td>
<td>9,211,000</td>
</tr>
<tr>
<td></td>
<td>$197,513,000</td>
<td>$190,329,000</td>
</tr>
</tbody>
</table>

|                      |        |        |
|                      | $378,673,000 | $373,488,000 |

The accompanying notes are an integral part of the financial statements.
### CURRENT FUNDS

<table>
<thead>
<tr>
<th>Description</th>
<th>1975</th>
<th>1974</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounts payable and accruals</td>
<td>$15,151,000</td>
<td>$17,712,000</td>
</tr>
<tr>
<td>Withholdings, deposits and other credits</td>
<td>5,629,000</td>
<td>4,976,000</td>
</tr>
<tr>
<td>Advances by the U.S. Government for certain research contracts and grants</td>
<td>11,822,000</td>
<td>13,919,000</td>
</tr>
<tr>
<td>Unexpended grants for sponsored research from private sources</td>
<td>421,000</td>
<td>959,000</td>
</tr>
<tr>
<td>Gifts and other receipts available for current expenses</td>
<td>10,743,000</td>
<td>9,660,000</td>
</tr>
<tr>
<td></td>
<td><strong>$43,766,000</strong></td>
<td><strong>$47,226,000</strong></td>
</tr>
</tbody>
</table>

### INVESTED FUNDS

**Endowment funds (Note B):**

<table>
<thead>
<tr>
<th>Description</th>
<th>1975</th>
<th>1974</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income for general purposes</td>
<td>$76,351,000</td>
<td>$76,067,000</td>
</tr>
<tr>
<td>Income for designated purposes</td>
<td>121,754,000</td>
<td>117,832,000</td>
</tr>
<tr>
<td>Net realized gain from investments</td>
<td>41,143,000</td>
<td>40,652,000</td>
</tr>
<tr>
<td>Student loan funds (Note C)</td>
<td>16,472,000</td>
<td>14,802,000</td>
</tr>
<tr>
<td>Building funds</td>
<td>5,920,000</td>
<td>5,980,000</td>
</tr>
<tr>
<td>Other expendable funds:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General purposes</td>
<td>861,000</td>
<td></td>
</tr>
<tr>
<td>Designated purposes</td>
<td>39,826,000</td>
<td>46,224,000</td>
</tr>
<tr>
<td>Unexpended endowment income for designated purposes.</td>
<td>4,680,000</td>
<td>4,267,000</td>
</tr>
<tr>
<td>Agency funds</td>
<td>809,000</td>
<td>796,000</td>
</tr>
<tr>
<td>Funds subject to life interests in income</td>
<td>6,361,000</td>
<td>6,359,000</td>
</tr>
<tr>
<td>Investment income for distribution to funds</td>
<td>19,987,000</td>
<td>21,325,000</td>
</tr>
<tr>
<td></td>
<td><strong>$334,164,000</strong></td>
<td><strong>$334,304,000</strong></td>
</tr>
<tr>
<td>Notes payable — student loans (Note D)</td>
<td>2,100,000</td>
<td>600,000</td>
</tr>
<tr>
<td>— investment real estate (Note D)</td>
<td>738,000</td>
<td>1,032,000</td>
</tr>
<tr>
<td>Notes payable — N.D.E.A. (Note D)</td>
<td>392,000</td>
<td>297,000</td>
</tr>
<tr>
<td></td>
<td><strong>$337,940,000</strong></td>
<td><strong>$336,233,000</strong></td>
</tr>
</tbody>
</table>

### EDUCATIONAL PLANT FUNDS

<table>
<thead>
<tr>
<th>Description</th>
<th>1975</th>
<th>1974</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortgage bonds and notes payable (Note D)</td>
<td>$26,892,000</td>
<td>$27,440,000</td>
</tr>
<tr>
<td>Due to invested funds</td>
<td>7,199,000</td>
<td>5,628,000</td>
</tr>
<tr>
<td>Funds used for educational plant</td>
<td>163,422,000</td>
<td>156,961,000</td>
</tr>
<tr>
<td></td>
<td><strong>$197,513,000</strong></td>
<td><strong>$190,029,000</strong></td>
</tr>
<tr>
<td></td>
<td><strong>$378,673,000</strong></td>
<td><strong>$373,488,000</strong></td>
</tr>
</tbody>
</table>
Treasurer of the Corporation

STATEMENT OF CHANGES IN FUND BALANCES
FOR THE YEAR ENDED JUNE 30, 1975

Schedule C

<table>
<thead>
<tr>
<th>Fund Type</th>
<th>Balance June 30, 1974</th>
<th>Gifts and Other Receipts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Endowment funds (Note B):</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income for general purposes</td>
<td>$76,067,000</td>
<td>$195,000</td>
</tr>
<tr>
<td>Income for designated purposes</td>
<td>117,832,000</td>
<td>3,740,000</td>
</tr>
<tr>
<td>Net realized gain from investments</td>
<td>40,652,000</td>
<td>491,000</td>
</tr>
<tr>
<td>Student loan funds (Note C)</td>
<td>14,802,000</td>
<td>1,639,000</td>
</tr>
<tr>
<td>Building funds</td>
<td>5,980,000</td>
<td>5,221,000</td>
</tr>
<tr>
<td><strong>Other expendable funds:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General purposes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Designated purposes</td>
<td>46,224,000</td>
<td>4,149,000</td>
</tr>
<tr>
<td>Unexpended endowment income for designated purposes</td>
<td>4,267,000</td>
<td>-</td>
</tr>
<tr>
<td>Agency funds</td>
<td>796,000</td>
<td>61,000</td>
</tr>
<tr>
<td>Funds subject to life interests in income</td>
<td>6,359,000</td>
<td>35,000</td>
</tr>
<tr>
<td>Investment income for distribution to funds</td>
<td>21,325,000</td>
<td>-</td>
</tr>
<tr>
<td>Current year's general investment income</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total invested funds</strong></td>
<td>$334,304,000</td>
<td>$18,169,000</td>
</tr>
<tr>
<td>Gifts and other receipts available for current expenses</td>
<td>9,660,000</td>
<td>14,338,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$343,964,000</td>
<td>$32,507,000</td>
</tr>
</tbody>
</table>

Gifts and bequests received during the year added to funds (Note A) $16,782,000
Royalties received net of related costs 455,000
Receipts from foundations and agencies for student aid 5,252,000
Net gain on sales of investments 443,000
Appropriations from research contract allowances 1,465,000
Government student loan support 975,000
Government construction grants 499,000
Fees, services and other receipts 6,636,000

Endowment investment income used to meet expenses of current operation
Gifts, investment income and other receipts used to meet expenses of current operation

Scholarship and fellowship awards for tuition and stipends
Expenditures for buildings added to educational plant
Expenditures of service activities and other charges to funds not representing operating expenses
Operating expenses recorded in direct expenses of the Division of Sponsored Research

The accompanying notes are an integral part of the financial statements
Schedule C (continued)

<table>
<thead>
<tr>
<th>Investment Income (Note B)</th>
<th>Transfers In-(Out)</th>
<th>Expenses</th>
<th>Other Charges</th>
<th>Balance June 30, 1975</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ 6,517,000</td>
<td></td>
<td></td>
<td></td>
<td>$ 76,351,000</td>
</tr>
<tr>
<td>*</td>
<td>182,000</td>
<td></td>
<td></td>
<td>121,754,000</td>
</tr>
<tr>
<td>578,000</td>
<td>(578,000)</td>
<td></td>
<td></td>
<td>41,143,000</td>
</tr>
<tr>
<td>11,000</td>
<td>(42,000)</td>
<td>288,000</td>
<td>(350,000)</td>
<td>16,472,000</td>
</tr>
<tr>
<td>273,000</td>
<td>(582,000)</td>
<td>603,000</td>
<td>4,369,000</td>
<td>5,920,000</td>
</tr>
<tr>
<td>40,000</td>
<td>3,406,000</td>
<td>4,595,000</td>
<td>628,000</td>
<td>861,000</td>
</tr>
<tr>
<td>2,601,000</td>
<td>(5,615,000)</td>
<td>2,044,000</td>
<td>5,489,000</td>
<td>39,826,000</td>
</tr>
<tr>
<td>9,261,000</td>
<td>(1,229,000)</td>
<td>4,078,000</td>
<td>3,541,000</td>
<td>4,680,000</td>
</tr>
<tr>
<td>43,000</td>
<td>(30,000)</td>
<td></td>
<td>61,000</td>
<td>809,000</td>
</tr>
<tr>
<td>318,000</td>
<td>(65,000)</td>
<td></td>
<td>286,000</td>
<td>6,361,000</td>
</tr>
<tr>
<td>{(19,718,000)}</td>
<td>{(28,000)}</td>
<td></td>
<td></td>
<td>19,987,000</td>
</tr>
<tr>
<td>{1,120,000}</td>
<td>{17,288,000}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17,288,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$ 18,332,000</td>
<td>$(4,581,000))</td>
<td>$ 18,036,000</td>
<td>$ 14,024,000</td>
<td>$334,164,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$ 18,332,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\*Investment income on endowment funds for designated purposes is included under the caption "Unexpended endowment income for designated purposes."
SUMMARY OF CHANGES IN INVESTED FUND BALANCES
for the ten years ended June 30, 1975
(In thousands of dollars)

Schedule D

<table>
<thead>
<tr>
<th>Sources of funds</th>
<th>1975</th>
<th>1974</th>
<th>1973</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gifts and bequests (Note A)</td>
<td>$16,782</td>
<td>$19,475</td>
<td>$18,407</td>
</tr>
<tr>
<td>Investment income (Note B)</td>
<td>18,332</td>
<td>19,099</td>
<td>18,321</td>
</tr>
<tr>
<td>Net gain on sales or exchanges of investments</td>
<td>443</td>
<td>712</td>
<td>2,429</td>
</tr>
<tr>
<td>Royalties received net of related costs</td>
<td>455</td>
<td>953</td>
<td>1,310</td>
</tr>
<tr>
<td>Receipts from foundations and agencies for student aid</td>
<td>5,252</td>
<td>4,321</td>
<td>3,999</td>
</tr>
<tr>
<td>Appropriations from research contract allowances</td>
<td>1,465</td>
<td>1,426</td>
<td>1,457</td>
</tr>
<tr>
<td>Government construction grants</td>
<td>499</td>
<td>3,024</td>
<td>651</td>
</tr>
<tr>
<td>Government grant for student loans</td>
<td>975</td>
<td>946</td>
<td>816</td>
</tr>
<tr>
<td>Fees, services and other receipts</td>
<td>6,636</td>
<td>2,406</td>
<td>2,490</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$50,839</strong></td>
<td><strong>$52,362</strong></td>
<td><strong>$49,880</strong></td>
</tr>
</tbody>
</table>

Use of funds:

<table>
<thead>
<tr>
<th>Used to meet expenses of current operation</th>
<th>1975</th>
<th>1974</th>
<th>1973</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endowment investment income (Note B)</td>
<td>$10,506</td>
<td>$9,681</td>
<td>$9,794</td>
</tr>
<tr>
<td>Gifts, investment income and other receipts</td>
<td>18,602</td>
<td>17,357</td>
<td>9,193</td>
</tr>
<tr>
<td>Scholarship and fellowship awards for tuition and stipends</td>
<td>8,285</td>
<td>7,711</td>
<td>7,965</td>
</tr>
<tr>
<td>Additions to educational plant</td>
<td>5,867</td>
<td>10,129</td>
<td>11,969</td>
</tr>
<tr>
<td>Operating expenses recorded in direct expenses of the Office of Sponsored Programs</td>
<td>673</td>
<td>983</td>
<td>1,640</td>
</tr>
<tr>
<td>Other charges to funds not related to current operation</td>
<td>5,963</td>
<td>4,595</td>
<td>2,579</td>
</tr>
<tr>
<td><strong>Net increase in funds</strong></td>
<td><strong>49,896</strong></td>
<td><strong>50,456</strong></td>
<td><strong>43,140</strong></td>
</tr>
<tr>
<td><strong>Fund balances at end of year</strong></td>
<td><strong>344,907</strong></td>
<td><strong>343,964</strong></td>
<td><strong>342,058</strong></td>
</tr>
</tbody>
</table>

Less gifts and other receipts available for current expenses

<table>
<thead>
<tr>
<th>Total invested funds</th>
<th>1975</th>
<th>1974</th>
<th>1973</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>$334,164</strong></td>
<td><strong>$334,304</strong></td>
<td><strong>$333,131</strong></td>
<td></td>
</tr>
</tbody>
</table>

The accompanying notes are an integral part of the financial statements
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$328,247</td>
<td>$302,901</td>
<td>$290,598</td>
<td>$259,882</td>
<td>$239,902</td>
<td>$229,119</td>
<td>$190,722</td>
</tr>
<tr>
<td>$ 18,440</td>
<td>$ 35,591</td>
<td>$ 15,878</td>
<td>$ 25,069</td>
<td>$ 22,147</td>
<td>$ 16,019</td>
<td>$ 39,186</td>
<td></td>
</tr>
<tr>
<td>16,942</td>
<td>15,498</td>
<td>15,523</td>
<td>14,579</td>
<td>13,502</td>
<td>12,788</td>
<td>10,455</td>
<td></td>
</tr>
<tr>
<td>1,931</td>
<td>7,598</td>
<td>6,768</td>
<td>14,068</td>
<td>9,221</td>
<td>3,008</td>
<td>5,153</td>
<td></td>
</tr>
<tr>
<td>978</td>
<td>1,058</td>
<td>963</td>
<td>1,772</td>
<td>698</td>
<td>709</td>
<td>519</td>
<td></td>
</tr>
<tr>
<td>4,280</td>
<td>4,787</td>
<td>4,441</td>
<td>4,624</td>
<td>4,698</td>
<td>4,881</td>
<td>4,821</td>
<td></td>
</tr>
<tr>
<td>1,383</td>
<td>1,209</td>
<td>1,698</td>
<td>1,405</td>
<td>1,627</td>
<td>1,921</td>
<td>1,571</td>
<td></td>
</tr>
<tr>
<td>776</td>
<td>92</td>
<td>2,188</td>
<td>2,028</td>
<td>1,793</td>
<td>1,294</td>
<td></td>
<td></td>
</tr>
<tr>
<td>923</td>
<td>874</td>
<td>556</td>
<td>639</td>
<td>677</td>
<td>850</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,778</td>
<td>2,781</td>
<td>3,141</td>
<td>2,921</td>
<td>3,007</td>
<td>1,276</td>
<td>1,078</td>
<td></td>
</tr>
<tr>
<td>$ 48,431</td>
<td>$ 69,396</td>
<td>$ 49,060</td>
<td>$ 67,265</td>
<td>$ 57,827</td>
<td>$ 43,072</td>
<td>$ 64,927</td>
<td></td>
</tr>
<tr>
<td>$ 9,602</td>
<td>$ 8,435</td>
<td>$ 7,354</td>
<td>$ 7,351</td>
<td>$ 6,865</td>
<td>$ 4,859</td>
<td>$ 4,490</td>
<td></td>
</tr>
<tr>
<td>9,471</td>
<td>14,529</td>
<td>13,704</td>
<td>10,344</td>
<td>11,113</td>
<td>9,970</td>
<td>8,242</td>
<td></td>
</tr>
<tr>
<td>8,162</td>
<td>7,999</td>
<td>7,533</td>
<td>7,279</td>
<td>7,566</td>
<td>6,879</td>
<td>5,703</td>
<td></td>
</tr>
<tr>
<td>9,151</td>
<td>6,513</td>
<td>4,283</td>
<td>7,067</td>
<td>10,076</td>
<td>8,509</td>
<td>6,815</td>
<td></td>
</tr>
<tr>
<td>2,246</td>
<td>2,869</td>
<td>2,627</td>
<td>1,957</td>
<td>1,062</td>
<td>1,241</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>2,728</td>
<td>3,705</td>
<td>1,256</td>
<td>2,551</td>
<td>965</td>
<td>831</td>
<td>1,208</td>
<td></td>
</tr>
<tr>
<td>41,360</td>
<td>44,050</td>
<td>36,757</td>
<td>36,549</td>
<td>37,647</td>
<td>32,289</td>
<td>26,530</td>
<td></td>
</tr>
<tr>
<td>7,071</td>
<td>25,346</td>
<td>12,303</td>
<td>30,716</td>
<td>19,980</td>
<td>10,783</td>
<td>38,397</td>
<td></td>
</tr>
<tr>
<td>335,318</td>
<td>328,247</td>
<td>302,901</td>
<td>290,598</td>
<td>259,882</td>
<td>239,902</td>
<td>229,119</td>
<td></td>
</tr>
<tr>
<td>7,680</td>
<td>6,893</td>
<td>8,900</td>
<td>7,775</td>
<td>6,441</td>
<td>6,939</td>
<td>7,064</td>
<td></td>
</tr>
<tr>
<td>$327,638</td>
<td>$321,354</td>
<td>$294,001</td>
<td>$282,823</td>
<td>$253,441</td>
<td>$232,963</td>
<td>$222,055</td>
<td></td>
</tr>
</tbody>
</table>
### STATEMENT OF SOURCE AND APPLICATION OF FUNDS

for the year ended June 30, 1975  
(in thousands of dollars)

#### Schedule E

<table>
<thead>
<tr>
<th></th>
<th>Current Funds</th>
<th>Invested Funds</th>
<th>Educational Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Restricted Unexpend</td>
<td>Unexpend</td>
<td>Student</td>
</tr>
<tr>
<td></td>
<td>endowment Income</td>
<td>edendit</td>
<td>Loans</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gifts &amp; Grants</td>
<td></td>
</tr>
<tr>
<td>Balances at Beginning of Year</td>
<td>$......</td>
<td>$ 4,267</td>
<td>$ 10,619</td>
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<tr>
<td>Tuition and Other Income</td>
<td>$29,950</td>
<td>$......</td>
<td>$......</td>
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<td>Research Revenues:</td>
<td></td>
<td></td>
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<tr>
<td>Departmental &amp; Interdepartmental</td>
<td>21,556</td>
<td>64,992</td>
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<tr>
<td>Lincoln Laboratory</td>
<td>8,973</td>
<td>72,922</td>
<td></td>
</tr>
<tr>
<td>Draper Laboratory</td>
<td>152</td>
<td>1,162</td>
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<tr>
<td>Educational Plant Funded From</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary Activities</td>
<td></td>
<td>9,800</td>
<td></td>
</tr>
<tr>
<td>Grants-in-Aid.</td>
<td></td>
<td>3,500</td>
<td></td>
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<tr>
<td>Grants in Aid used in Sponsored</td>
<td></td>
<td>(4,038)</td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gifts &amp; Bequests Received</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Added to Funds</td>
<td>2,173</td>
<td>4,187</td>
<td>124</td>
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<td>Patent Royalties Received Net of Cost</td>
<td>446</td>
<td>6</td>
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<tr>
<td>Receipts from Foundations &amp; Agencies</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>for Student Aid.</td>
<td></td>
<td></td>
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<tr>
<td>Net Gain or (Loss) on Sale of</td>
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<td></td>
<td></td>
</tr>
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<td>Investments</td>
<td></td>
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<td></td>
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<tr>
<td>Funds Used for Research Contract</td>
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<td></td>
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<tr>
<td>Allowances</td>
<td>10</td>
<td>196</td>
<td></td>
</tr>
<tr>
<td>Government Student Loan Support</td>
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<td>Government Construction Grants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fees, Service &amp; Other Receipts</td>
<td>9</td>
<td>4,693</td>
<td>540</td>
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<tr>
<td>Investment Income</td>
<td>6,557</td>
<td>9,261</td>
<td></td>
</tr>
<tr>
<td>Real Estate Investment Income</td>
<td>(323)*</td>
<td></td>
<td></td>
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<tr>
<td>Supplemented from Funds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal New Resources</td>
<td>$69,503</td>
<td>$9,261</td>
<td>$162,676</td>
</tr>
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</table>
### Statement of Source and Application of Funds (continued)

<table>
<thead>
<tr>
<th>Borrowed Capital:</th>
<th>$.........</th>
<th>$.........</th>
<th>$.........</th>
<th>$.........</th>
<th>$.........</th>
<th>$.........</th>
<th>$.........</th>
<th>$.........</th>
<th>$.........</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borrowings for Educational Plant . . .</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
</tr>
<tr>
<td>Borrowings for Student Aid . . .</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
</tr>
<tr>
<td>Total New Resources:</td>
<td>$69,503</td>
<td>$9,261</td>
<td>$162,676</td>
<td>$3,858</td>
<td>$4,427</td>
<td>$4,340</td>
<td>$457</td>
<td>$5,494</td>
<td>$594</td>
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<tr>
<td>Total Resources Including Beginning Balance</td>
<td>$69,503</td>
<td>$13,528</td>
<td>$173,295</td>
<td>$19,557</td>
<td>$240,008</td>
<td>$71,889</td>
<td>$7,610</td>
<td>$11,474</td>
<td>$184,994</td>
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<tr>
<td></td>
<td>$79,158</td>
<td>$15,387</td>
<td>$192,851</td>
<td>$24,414</td>
<td>$261,096</td>
<td>$79,505</td>
<td>$9,110</td>
<td>$12,948</td>
<td>$200,460</td>
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<table>
<thead>
<tr>
<th>Resources Applied:</th>
<th>$.........</th>
<th>$.........</th>
<th>$.........</th>
<th>$.........</th>
<th>$.........</th>
<th>$.........</th>
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<th>$.........</th>
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</thead>
<tbody>
<tr>
<td>Current Operating Expenses:</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
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<td>$.........</td>
<td>$.........</td>
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<tr>
<td>Auxiliary Activities . . .</td>
<td>$.........</td>
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<td>$.........</td>
<td>$.........</td>
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<td>Instruction and Research:</td>
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<td>$.........</td>
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</tr>
<tr>
<td>Restricted Funds:</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
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<td>$.........</td>
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<tr>
<td>Unrestricted Funds:</td>
<td>$.........</td>
<td>$.........</td>
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<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
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<td>Special Unrestricted</td>
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<tr>
<td>Other Unrestricted</td>
<td>65,583</td>
<td>$159,947</td>
<td>$288</td>
<td>$603</td>
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<tr>
<td></td>
<td>$70,189</td>
<td>$4,078</td>
<td>$159,947</td>
<td>$288</td>
<td>$603</td>
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<tr>
<td>Alumni Association</td>
<td>$963</td>
<td></td>
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<td>Joint Center for Urban Studies . . .</td>
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<td>Federal Fellowships . .</td>
<td>247</td>
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<td>Undergraduate Scholarship Funding - 1975 and prior</td>
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<tr>
<td>Special Scholarship Program . .</td>
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<tr>
<td>MHEFA &amp; Dining Funding . .</td>
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<tr>
<td>Interest on Advances for Construction .</td>
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<tr>
<td>Health Science and Technology Program .</td>
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<td></td>
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<td>M.I.T. Press . .</td>
<td>645</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
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<td>Urban Systems Laboratory .</td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>Energy Laboratory .</td>
<td>60</td>
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<td>Other Special Items .</td>
<td>48</td>
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<tr>
<td>Operating Expense Recorded in Direct Expense for DSR .</td>
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<td></td>
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<td>Other Scholarships and Fellowships .</td>
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<tr>
<td>Service Activities and Other Charges not representing Operating Expense .</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Subtotal Resources Applied:</td>
<td>$73,564</td>
<td>$7,619</td>
<td>$165,298</td>
<td>$4196</td>
<td>$343</td>
<td>$573</td>
<td>$251,531</td>
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<td></td>
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<tr>
<td>Retirement of Debt:</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction of Debt for Educational Plant . . .</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td>$.........</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction of Debt for Student Aid . . .</td>
<td>$613</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction of Debt for Investment R. E. .</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Resources Applied:</td>
<td>$73,564</td>
<td>$7,619</td>
<td>$165,298</td>
<td>$551</td>
<td>$294</td>
<td>$4,196</td>
<td>$343</td>
<td>$573</td>
<td>$252,986</td>
</tr>
<tr>
<td>Balance Before Transfers and Appropriations .</td>
<td>$4,061</td>
<td>$5,909</td>
<td>$7,997</td>
<td>$19,006</td>
<td>$239,714</td>
<td>$67,693</td>
<td>$7,267</td>
<td>$10,901</td>
<td>$184,446</td>
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<tr>
<td></td>
<td>$538,872</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
## Statement of Source and Application of Funds

### Current Funds

<table>
<thead>
<tr>
<th>Description</th>
<th>Restricted</th>
<th>Invested Funds</th>
<th>Educational Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unexpended Endowment Income</td>
<td>$446</td>
<td>$464</td>
<td>$5,867</td>
</tr>
<tr>
<td>Unexpended Gifts &amp; Grants</td>
<td>$...</td>
<td>$...</td>
<td>$...</td>
</tr>
<tr>
<td>Student Endowment</td>
<td>$...</td>
<td>$...</td>
<td>$...</td>
</tr>
<tr>
<td>Designated Purpose</td>
<td>$...</td>
<td>$...</td>
<td>$...</td>
</tr>
<tr>
<td>Annuity and Life Income</td>
<td>$...</td>
<td>$...</td>
<td>$...</td>
</tr>
<tr>
<td>Unexpended Educational Funds</td>
<td>$...</td>
<td>$...</td>
<td>$...</td>
</tr>
<tr>
<td>Total Transfers and Appropriations</td>
<td>$4,922</td>
<td>$660</td>
<td>$538,872</td>
</tr>
<tr>
<td>Balance at June 30, 1975</td>
<td>$861</td>
<td>$4,680</td>
<td>$190,313</td>
</tr>
</tbody>
</table>

*Unrestricted Funds used for Other Charges . $3,689

**Unrestricted Funds used for Operations . $4,596

***Sum of Unrestricted Funds for Operations and Other Charges . $8,285

The accompanying notes are an integral part of the financial statements.
NOTES TO FINANCIAL STATEMENTS

A. Accounting Policies

Basis of Presentation
The accompanying financial statements have been prepared on the accrual basis. In order to ensure observance of limitations and restrictions placed on the use of the resources available to the Institute, the accounts of the Institute have been maintained in accordance with the principles of "fund accounting." This is the procedure by which resources for various purposes are classified for accounting and reporting purposes into funds that are in accordance with activities or objectives specified.

Sponsored Research
Revenue associated with contracts and grants is recognized as related costs are incurred. Grants and contracts normally provide for a use allowance, in lieu of depreciation, which is reflected as unrestricted revenue. The Institute has recorded reimbursement of indirect costs relating to Government contracts and grants at the authorized billing rate for the fiscal year ended June 30, 1975, which is subject to final negotiation after Government audit.

Educational Plant
Educational Plant, representing land, buildings, and equipment, is shown at cost. As is customary for educational institutions, depreciation has not been recorded on educational plant. When expended costs associated with the construction of new educational plant facilities are shown as construction in progress until such projects are completed.

Gifts
Gifts are recognized upon receipt. Gifts other than cash are recorded at their fair market value when such values are determinable as of the date of contribution.

Vacations
The Institute accrues vacation expense earned by certain research related employees. Other vacations are expensed as taken.

Interfund Borrowings
Interfund borrowings by Educational Plant include short-term advances of $5,825,000 as well as $1,374,000 of borrowings from invested funds (at 5% and 6% interest) related to the temporary funding of certain buildings.

B. Investments and Invested Funds

Total market value of investments approximated $402,475,000 and $388,176,000 at June 30, 1975 and 1974 respectively. Such amounts include market values of certain real estate which were determined by professional appraisers. The Institute records bond interest as received and does not accrue discount. See the schedule of investments which appears in the Treasurer's Report for further details.

At June 30, 1975, the Institute has reserved $19,987,000 (captioned "Investment income for distribution to funds") representing endowment fund income in excess of amounts distributed to funds in 1974 and prior years. In 1975 the unallocated investment income reserve was reduced by $1,338,000, whereas $177,000 was added to this reserve in 1974.
Treasurer of the Corporation

The Institute is reviewing the source of designation of its funds in order to classify the funds between Corporation Designated (quasi endowment) funds and Donor Designated (true endowment) funds. The Institute has accounted for the funds and the income thereon in accordance with the restrictions designated by the donor or by the Corporation. Preliminary results of the review indicate that a substantial portion of the endowment funds are in the nature of quasi endowment. A similar portion of the income for distribution to funds is in the nature of income applicable to quasi endowment funds upon distribution. The final results of the review will be set forth in the financial statements upon its completion.

C. Student Loan Funds

National Direct Student Loan Funds of $8,814,000 and $7,839,000 at June 30, 1975 and 1974, respectively, are ultimately refundable to the United States Government.

D. Mortgage Bonds and Notes Payable

Mortgage Bonds and Notes Payable consist of the following at June 30, 1975 and 1974:

M.I.T. Construction and Consolidation Bonds of 1968:
<table>
<thead>
<tr>
<th>Series</th>
<th>1975</th>
<th>1974</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, 3%, due 1975-2003</td>
<td>$4,968,000</td>
<td>$5,073,000</td>
</tr>
<tr>
<td>B, 3%, due 1975-2015</td>
<td>3,736,000</td>
<td>3,776,000</td>
</tr>
<tr>
<td>C, 3%, due 1975-2018</td>
<td>1,610,000</td>
<td>1,625,000</td>
</tr>
<tr>
<td>Total</td>
<td>$10,314,000</td>
<td>$10,474,000</td>
</tr>
</tbody>
</table>

Dining facilities bonds, 3%, due 1975-1999 | 311,000 | 319,000 |
Mortgage notes payable, 5%, due 1975-1978 | 385,000 | 482,000 |
Mortgage notes payable, 5 1/4%, due 1975-1981 | 452,000 | 527,000 |
Residential facility lease purchase obligation (note E) | 5,310,000** | 5,373,000** |
Mortgage notes payable, 5-6 1/2%, due 1975-2003 (note E) | 10,120,000 | 10,265,000 |

Total related to educational plant | $26,892,000* | $27,440,000*

Notes payable, 6%, due 1975-1976 | 93,000 | 186,000 |
Notes payable, 6%, due 1975-1978 | 547,000 | 699,000 |
Notes payable, non interest-bearing, due 1975-1977 | 98,000 | 147,000 |

Total related to investment real estate | $738,000 | $1,032,000 |

Notes payable to bank, 7%, due 1976, for student loans | $1,050,000 | 600,000 |
Notes payable to Student Loan Marketing Association, 9 1/4%, due 1976 | 1,000,000 | — |
Notes payable to bank, 10%, due 1976 for Faculty and Staff Educational Loan Fund | 50,000 | — |
Notes payable to U.S. Government, 6%-7 1/2%, due 1975-1990, for student loans | 392,000 | 297,000 |

*At June 30, 1975, the Institute had pledged securities with a market value of $4,492,000, annual unrestricted operating revenue of $2,120,000, and certain other project revenue to comply with the terms of the bond indentures.
**The Institute receives interest supplements from the Department of Housing and Urban Development with respect to these issues.
E. Commitments

1. During 1970, the Massachusetts Health and Educational Facilities Authority agreed to construct a Residence Facility and provide additions to Heating and Chilled Water Plant for lease to the Institute, with title passing to the Institute upon expiration of the leases. Construction costs of $10,500,000 were met by an issue of Authority Bonds with the Institute paying the additional costs required to complete the Residence Facility. Construction costs of the Residence Facility incurred to date, recorded as educational plant, amount to $7,570,000, of which $5,310,000 represents the associated liability to the Authority. Annual payments under the thirty-year lease purchase obligation approximate $350,000. Annual rentals for the Utility Facilities, which are being leased for their estimated 25-year useful lives, approximate $400,000 and are being charged to plant operations as incurred.

2. During 1973, the Massachusetts Health and Educational Facilities Authority financed the retirement of advances previously made by the Institute in connection with existing dormitory facilities, and in part, construction of the Chemical Engineering Facility and renovation of a dormitory facility. Project costs of approximately $25,105,000 have been met, in part, by an issue of Authority Bonds of $10,400,000 which are supported by mortgages given by the Institute on certain of the project facilities.

Costs of the Project incurred to June 30, 1975, recorded as educational plant, amount to $18,140,000, of which $10,120,000 represents an associated liability to the Authority. At June 30, 1975, the Institute had $1,441,000 ($6,921,000 at June 30, 1974) representing proceeds from the bond issue together with interest thereon on deposit with the Authority.

3. The Institute is committed under real estate leases to a gross annual payment of $487,000 in 1976, and approximately $100,000 annually thereafter through 1978. Such amounts will be reduced by subleases approximating $100,000 per year. Certain leases expiring in 1976 are subject to renewal or may be renewed.

F. Retirement Funds

The Institute's retirement plans, which cover substantially all employees, are under the supervision of trustees. Plan assets are not included in the Institute's financial statements. Current service costs of the plans are funded as incurred; prior service costs are being funded over approximately twelve years. Pension expense charged to operations was $7,453,000 and $7,626,000 in fiscal 1975 and 1974, respectively, the reduction in expense being primarily attributable to the divestment of Draper Laboratory.
AUDITOR'S REPORT

To the Auditing Committee of the Massachusetts Institute of Technology:

We have examined the following financial statements of Massachusetts Institute of Technology:


Our examinations were made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the aforementioned financial statements present fairly the financial position of Massachusetts Institute of Technology at June 30, 1975 and 1974, and the sources of revenues and funds used to meet expenses of current operations for the years then ended, changes in fund balances and the source and application of funds for the year ended June 30, 1975, and the summarized changes in invested fund balances for the ten years then ended, in conformity with generally accepted accounting principles applied on a consistent basis.

COOPERS & LYBRAND

Boston, Massachusetts, September 16, 1975
The Secretary of the Institute is responsible for the provision of support services to the Corporation, its Officers, and Committees. This report summarizes the work of the Institute's governing body under the chairmanship of Howard W. Johnson.

**Corporation Membership**

There were 32 individuals whose membership status changed during 1974-75, in an unusually busy year for the Membership Committee. For the first time in several years all categories of membership in the Corporation were affected by these changes. At the year's end a record total of 90 Members of the Corporation included 77 Active Members, 12 Life Members Emeriti, and one Member-Elect due to assume office at the October 3, 1975 Annual Meeting of the Corporation as a Representative from Recent Classes.

The Corporation lost through death on July 3, 1974, its eldest active Life Member, James M. Barker, '07, former Chairman of Allstate Insurance Company, who had served for 39 years in the Corporation; and on October 14, 1974, its senior Life Member, Bradley Dewey, '09, co-founder and former President of Dewey & Almy Chemical Company, who had served for 43 years in the Corporation. Mr. Dewey's tenure was the fifth longest since the founding of the Institute.

At its December 6, 1974 Meeting, the Corporation elected the following to five-year terms effective immediately: Maurice F. Granville, '39, Chairman and Chief Executive Officer, Texaco, Inc.; Paul F. Hellmuth, '47, Senior Managing Partner, Hale and Dorr; and Richard L. Terrell, '58, Vice Chairman, General Motors Corporation. At the March 7, 1975 Meeting, Gregory C. Chisholm, '73, assumed office as a Representative from Recent Classes, having been elected previously at the May 31, 1974 Meeting of the Corporation.

On January 1, 1975, the incoming Governor of the Commonwealth of Massachusetts, His Excellency Michael S. Dukakis, succeeded Francis W. Sargent, '39, as a Representative of the Commonwealth. Also on January 1, 1975, James A. Champy, '63, resigned as a Member of the Corporation to accept an appointment at the Institute as Executive Vice President of the M.I.T. Alumni Association.

At its June 2, 1975 Meeting, the Corporation further elected the following to five-year terms, effective July 1, 1975: Virgilio Barco, '43, Senator of the Republic of Colombia; Vernon E. Jordan, Jr., Executive Director, National Urban League; Norman B. Leventhal, '38, President, The Beacon Companies; Wilfred D. MacDonnell, '34, President and Chief Executive Officer, Kelsey-Hayes Company; Allan J. MacEachen, '53, Secretary of State for External
Affairs, Canada; Harold J. Muckley, '39, Consultant and former President of Houston Contracting Company; Mary F. Wagley, '47, Headmistress, St. Paul's School for Girls; D. Reid Weedon, Jr., '41, Senior Vice President, Arthur D. Little, Inc.; and William J. Weisz, '48, President, Motorola, Inc. Shirley A. Jackson, '68, Research Associate, Fermi National Accelerator Laboratory, was elected a Representative from Recent Classes for five years, to assume office on October 3, 1975. In addition, Howard L. Richardson, '31, Consultant and corporate director, became an ex-officio Member of the Corporation by virtue of his election as the 1975-76 President of the Alumni Association. On July 1, 1975, he succeeded the Honorable Luis A. Ferré, '24, former Governor of the Commonwealth of Puerto Rico, who continues as a Life Member.

A new Officer of the Corporation, Glenn P. Strehle, '58, President of the Advisory Services Division of Colonial Management Associates, Inc., was elected Treasurer of the Corporation at the June 2, 1975 Meeting, effective July 1, 1975. Mr. Strehle, who has been a leader in the Boston financial community, has been active in Institute and alumni affairs for many years. In his new post, he succeeds Joseph J. Snyder, '44, who has served with distinction as Treasurer since 1950 and who continues as a consultant in the Office of the Treasurer. During his long and distinguished service, Mr. Snyder achieved national prominence among university financial officers, serving as M.I.T.'s chief financial officer during a 25-year period of unprecedented growth.

Our Life Member, Charles A. Thomas, '24, Chairman of the Board of Trustees of Washington University and former Chairman of the Board of Monsanto Company, transferred to Emeritus status after 25 years of active service. Our Life Member, Uncas A. Whitaker, '23, Chairman of the Board of AMP Incorporated, transferred to Emeritus status after nearly 14 years of active service.

Expiration of term membership has cost the Corporation the formal services of William S. Brewster, '39, Chairman of the Board, USM Corporation; Ralph M. Davison, '66, Manager of Stainless Steel Development, Climax Molybdenum Company; Sekazi K. Mtingwa, '71, a graduate student in Physics at Princeton University; and Philip H. Peters, '37, Senior Vice President, The John Hancock Mutual Life Insurance Company. These retiring Corporation Members continue their association with the Corporation in many ways as members of various Corporation and Institute committees.

M.I.T. Leadership Campaign

At its December 6, 1974 Meeting, the Corporation took formal action on a plan to initiate the five-year, $225 million M.I.T. Leadership Campaign. The public announcement was made in late April in a series of luncheons and dinner meetings hosted by Members of the Corporation in major cities throughout the country. A 17-member Campaign Steering Committee, comprised entirely of Corporation Members, is leading this unprecedented effort. Howard W. Johnson and Paul F. Hellmuth, '47 are Co-Chairmen. Other members of the Committee, in addition to Dr. James R. Killian, Jr., President Jerome B. Wiehner and Chancellor Paul E. Gray, are: Paul M. Cook, '47; Marshall B. Dalton, '15; Luis A. Ferré, '24; Robert C. Gunness, '34; Cecil H. Green, '23; J. Kenneth Jamieson, '31; Breene M. Kerr, '51; Paul V. Keyser, '29; Ralph Landau, '41; Carl M. Mueller, '41; Clint W. Murchison, Jr., '44; William B. Murphy; D. Reid Weedon, Jr., '41; Uncas A. Whitaker, '23; and John J. Wilson, '29.

No account of trusteeship at M.I.T. this year would be complete without recording the central responsibility the Corporation has accepted in carrying out this Campaign. Fortunately for
the Institute, all of the previous major campaign chairmen are active in the Steering Committee, and we have within the senior officers of M.I.T. seasoned leadership in securing major support from private sources. A Campaign staff under the direction of Vice President James B. Lampert has worked intensively with the faculty and staff for the past two years to support the planning of the Campaign with the Corporation Development Committee and the Alumni Association. Individual Corporation Members have made major personal commitments of time and resources to make possible a most auspicious beginning. The outcome will call forth M.I.T.'s best effort in the years immediately ahead. It will have a determining effect on the Institute's future as a world leader in scientific education.

Meetings

The Corporation held four meetings during the year. At a time of financial stringency, when Chairman Johnson, President Wiesner, and Chancellor Gray called upon all segments of the Institute community to pull together in planning for the future, the Corporation played a key role in communicating with students, faculty, alumni, and the general public on the range of questions and issues before M.I.T. Special thanks are due once again to the Ad Hoc Committee on Shareholder Responsibility, under the chairmanship of George W. Thorn, and to the Corporation Joint Advisory Committee under the chairmanship of Gregory Smith, for their continuing assistance to the Executive Committee and to the Corporation respectively. Walter L. Milne, Assistant to the President and the Chairman of the Corporation, served again as Secretary to the Committee on Shareholder Responsibility. Additional thanks are due the Corporation Screening Committee, under the chairmanship of Pamela T. Whitman, and the staff of the Alumni Association for the effort required to conduct the special alumni election needed to fill a vacancy in the membership category. Representatives from Recent Classes.

In notable actions the Corporation approved the recommendation of the faculty for name changes in Courses III and VI to the Department of Materials Science and Engineering and the Department of Electrical Engineering and Computer Science respectively. Also approved were the establishment of several new degree programs leading to an S.M. degree in Interdisciplinary Science, to be offered by the School of Science; an S.M. degree in Technology and Policy, to be offered by the departments of the School of Engineering; an S.B. degree in Nuclear Engineering; an S.B. degree in Computer Science and Engineering; and a Ph.D. degree in Architecture, Art, and Environmental Studies. As part of the change in name of Course VI, the S.M. degree in Electrical Engineering and Computer Science was substituted for the S.M. degree in Electrical Engineering.

Corporation Joint Advisory Committee (CJAC) on Institute-Wide Affairs

This Advisory Committee to the Corporation completed its sixth year of operation. At midyear the chairmanship changed from James A. Champy to Gregory Smith. The Committee held fewer meetings in 1974-75 than during the previous year; these included six regular, open sessions with various senior officers and the heads of administrative offices. Topics given special attention by CJAC included the organization of the Institute, M.I.T. and its surrounding community, admissions, and graduate student housing. Thanks are due Vice President Constantine B. Simonides, Dean Irwin W. Sizer, Walter L. Milne, Peter H. Richardson, Vice President Kenneth R. Wadleigh, and Dean Carola B. Eisenberg for their
presentations to CJAC on these and related subjects. The writer wishes to acknowledge once again the valuable contribution CJAC has made on these and other questions in building respect and mutual understanding within the M.I.T. community. Particular credit is due the chairman, Gregory Smith, for his skillful leadership of CJAC. The Committee was assisted in its deliberations by the able staff support of Robert D. Blake, for a fourth year.

Dedications and Special Functions

The Corporation continued to carry prime responsibility for dedications of major facilities. Notable ceremonies this year included the dedication of the following: The Ida M. Green Room, on December 4, 1974, in the Cecil and Ida Green Building, in conjunction with a convocation commemorating the tenth anniversary of the dedication of the Green Building; the Seeley G. Mudd Building, housing the M.I.T. Center for Cancer Research, the Cell Culture Center, and the Arteriosclerosis Center; a separate dedication of the Cell Culture Center; the James and Lynelle Holden Human Biology Teaching Laboratory, in Building 4, under the aegis of the Harvard-M.I.T. Program in Health Sciences and Technology; and the George R. Wallace, Jr. Geophysical Observatory in Westford, Massachusetts. The Department of Civil Engineering took the responsibility for dedicating a room and library in the Ralph W. Parsons Laboratory for Water Resources and Hydodynamics in memory of Institute Professor Arthur T. Ippen.

In October, 1974, the Corporation participated in an Institute-wide memorial service for Dr. Vannevar Bush. Additional special functions were held during the year to inaugurate and continue annual meetings with the Ida Green Fellows, Health Sciences Fellows, and McDer- mott Scholars.

Corporation Visiting Committees

As Provost Walter A. Rosenblith has stated, the Corporation Visiting Committees are essential organizers of the intellectual metabolism for the Institute. They also help in important ways to keep the Corporation and the senior officers of the Institute better informed of departmental plans and progress.

These advisory committees to the Corporation have now observed their one-hundredth year of operation at M.I.T. They were authorized by a vote of the Corporation on November 10, 1875, just 13 years after the charter of the Institute was accepted by its then government. For the first 60 years of their operation, the Corporation Visiting Committees were small four- or five-member committees composed entirely of M.I.T. Corporation Members. In the early 1930s the Institute moved to augment these Committees with nominees chosen by the Alumni Association and the President. Further expansion of the Alumni and Presidential nominees occurred in the late 1940s and 1950s and, more recently, in the present decade. Approximately 2,000 persons have served in these Committees over the 100-year span.

Each Visiting Committee now includes a new composition of at least three Corporation nominees, six Presidential nominees, and six Alumni nominees -- or 15-member committees in place of the previous nine-member committees. Some committees are slightly larger to provide for the representation of particular fields of specialization among the committee members. The most recent expansion process was begun five years ago. The total number of persons included is now 420 individuals holding 463 positions on the 29 Visiting Committees.
The year 1974-75 was a productive one for the Corporation Visiting Committees, with 18 meetings attended by some 200 members, or about half of the total Visiting Committee membership. For the third year running, there was less bunching of meetings in one or two spring months. Eight of the meetings occurred prior to the first of January, 1975. Several additional meetings were planned tentatively, but had to be postponed until fall, 1975.

This year the Corporation continued the Visiting Committee procedure involving the election of the Chairman of the Committees at the March instead of the October meeting of the Corporation. This change is being followed as a means of promoting better academic year scheduling of meetings by providing more working time in the spring to plan more effectively for the fall. The results to date lend continuing strong support to this move; five committees have already scheduled meetings for this coming fall, while several are actively planning for January and the winter months.

Several features of the meetings which have proved successful in the past were continued by the majority of the committees this year. All but one of the meetings included dinner at which the committee members were brought together informally with members of the faculty and administration and in a few cases with students. One committee combined with the department to hold a steak fry for students. Also, the committees made effective use of the sessions with students on their agenda, further formalizing this additional and valuable means of gaining insight into departmental activities. A number of the committees for larger departments included similar separate sessions with junior faculty. Discussions with each of the departments produced many common interests, including reviews of departmental progress in recruitments of minorities and women as students and faculty members. The Sloan School Visiting Committee, under the chairmanship of Paul V. Keyser, completed its highly successful experiment with a plan for small, tightly organized task forces to deal with particular aspects of the School’s program. The School of Architecture and Planning Visiting Committee, under the chairmanship of I.M. Pei, also obtained excellent results from another innovative approach, that of holding a planning meeting some months prior to the actual Visiting Committee meeting.

In one notable milestone in Visiting Committee leadership, our Life Member, Cecil H. Green, convened the Earth Sciences Visiting Committee on December 2 and 3, 1974, in his final session as Chairman of the Committee. He has served continually and brilliantly as Chairman of the Committee since 1968 and as a member of the Committee for 23 years. He continues as an active member of the Committee.

Attendance by members of the Visiting Committees has been excellent this year. The 18 meetings had an average of 11 members per meeting. In addition, the participation in this year's series of meetings by the senior officers and deans of the Institute continued at a high level. The presence of these officers at the various meetings enhances the interchange between the committee and the department and often provides a welcome catalytic effect which contributes to the success of the meeting. Warm thanks are due Provost Rosenblith for his energetic participation both in the meetings and in the selection of new committee members, and to the more than 300 faculty members who participated in the sessions of the Visiting Committees. At the March 7, 1975 Meeting of the Corporation, Dr. Rosenblith led an extensive discussion and review of the history and role of the Visiting Committees in academic planning at the Institute.

Of the 17 committees meeting in the 1973-74 year, all but two of the chairmen have now reported orally to the Corporation, and all have submitted written reports. These reports to the Corporation are important to the successful operation of the committees, and they provide a broadened forum in which to consider the plans and progress of each department. They are invaluable to the functioning of trusteeship at M.I.T. In an effort to economize and
to offset the increased costs associated with Visiting Committee operations, plans have been made to hold as many of the Visiting Committee functions as possible on the campus, to reduce reproduction and publicity costs, and to achieve other savings.

To conclude this report on the 1974-75 year, I note with appreciation the continued service of Robert D. Blake as Special Assistant in the Office of the Secretary, in providing staff support to the Corporation Visiting Committees and to CJAC.

V.A. FULMER
Alumni Association

Alumni Relations

To the extent that attendance is a measure of the success of Alumni Relations programs, the results of the past year were encouraging. The Alumni Officers' Conference in September, the reunions and Alumni Day in June, the Alumni Advisory Council meetings, and the regional programs and club meetings all showed increased attendance. Plans to strengthen the Association's information base and to output basic data on microfiche were implemented and completed. Plans for producing a computer generated Alumni Register in 1975 were implemented and, except for final edit and production, were completed. An additional staff member was added to support regional conferences and other major relations programs in support of the M.I.T. Leadership Campaign.

The findings of the Alumni Survey conducted by M.I.T.'s Analytical Studies and Planning Group in 1973-74 became available in late fall. The Survey indicated that, although most alumni had a positive attitude toward the Institute, only about one-tenth were reasonably well informed about M.I.T. today, whereas two-thirds expressed an interest in receiving more information and/or having closer ties with the Institute. This clearly suggested opportunities for improvement in alumni relations and therefore, during the latter half of the year, considerable staff effort with guidance from many senior alumni leaders was devoted to finding more effective means of communicating with and relating to alumni. This evolved into developing an organization that would provide a more integrated support of alumni activities by changing our field organization from staff specialists in fund raising, club, class, and other alumni programs to regional officers responsible for coordinating and supporting all alumni activities within a specified geographical area. These officers would report directly to the Executive Vice President. Internally, this involved replacing management functions with staff planning functions, and combining support activities in graphic design, logistics, data processing, and record keeping under single managers with functional responsibilities.

The following table of attendance over the past three years suggests an increasing interest in Institute related activities:

<table>
<thead>
<tr>
<th>Event</th>
<th>1974-75</th>
<th>1973-74</th>
<th>1972-73</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alumni Day &amp; Reunions</td>
<td>2,325</td>
<td>1,968</td>
<td>2,132</td>
</tr>
<tr>
<td>Alumni Officers' Conference</td>
<td>745</td>
<td>525</td>
<td>342</td>
</tr>
<tr>
<td>Alumni Advisory Council</td>
<td>802</td>
<td>589</td>
<td>621</td>
</tr>
<tr>
<td>Club Programs</td>
<td>9,800</td>
<td>7,400</td>
<td>8,600</td>
</tr>
<tr>
<td>Conferences &amp; Seminars</td>
<td>700</td>
<td>1,400</td>
<td>1,160</td>
</tr>
<tr>
<td>TOTAL</td>
<td>14,372</td>
<td>11,882</td>
<td>12,855</td>
</tr>
</tbody>
</table>
There were 143 club programs held during the past year. Highlights of these programs included a three-city tour in South America by Sloan School Dean William F. Pounds and Alumni Association President Luis A. Ferré, '24, which attracted 285 people in Bogota, Caracas, and Lima; a luncheon meeting in Chicago presenting Corporation Chairman Howard W. Johnson and attended by 550 people; a reception of the M.I.T. Club of Washington at the Iranian Embassy; and a seminar on "Innovations in Management" at Princeton, New Jersey.

Two regional conferences, one in Tampa on transportation and the other in Houston on energy, were sponsored this year by local alumni clubs. The purpose of these conferences was to allow M.I.T. faculty to present aspects of their work to audiences outside of Cambridge and to increase the visibility of the Institute's contributions to the solution of societal problems through the application of technology. The Houston conference accomplished these objectives in a two-day program. The first day included a general meeting for all attendees. The second day was devoted to private discussions between representatives from the corporate sponsors of the conference and the participating Institute faculty members.

The 1974 Alumni Officers' Conference, held on Friday and Saturday, September 13 and 14, had a record attendance of 745 alumni officers, faculty and spouses. The program focused on the preliminary results of the Alumni Survey Report and faculty presentations on "Food, Populations, Politics - The World Crisis." Nine Bronze Beaver Awards and two Presidential Citations were awarded to alumni in recognition of distinguished service to the Institute through Association programs.

The 1975 Alumni Day and Class Reunions also had a record attendance this year -- more than 2,000 alumni and their guests visited M.I.T. over a four-day period in June. All of the 14 quinquennial reunion classes held at least a portion of their reunion on campus, while nine reunion classes convened exclusively at M.I.T. Additionally, the Departments of Civil Engineering and Architecture hosted departmental reunions, consisting of banquet dinners and panel presentations. Besides the panels offered by these departments, more than 20 lectures and symposia, offered by a broad cross section of M.I.T. departments, were presented on Alumni Day to visiting alumni and the M.I.T. community.

Alumni Records and Data Processing

As of June 30, 1975, the rolls of living alumni included 64,061 names, resulting from the addition of 1,773 from the Class of 1974, and 1,439 from the Class of 1975, and the removal of 770 reported deceased during the academic year 1974-75.

Considerable efforts were devoted this year to preparing the Association's alumni records for computer processing, using microfiche output to replace outdated manual files, to permit verification of input, and to allow retrieval of business information. Once this conversion was completed, the process of producing a computer generated Alumni Register, to be available in fall, 1975, was implemented. In September, the Association also will have available a computer generated Directory of Alumni Officers, referenced by activity (e.g., Corporation, Board of Directors, Clubs, Fund, Educational Councils), by location, and alphabetically by name.

Nominations and Elections

In recent years considerable attention has been given by the members of the National Nominating Committee and by the Board of Directors to the function of the Committee and its role in the elective processes of the Alumni Association. Based on these considerations
and the comments received from alumni, the National Nominating Committee recommended to the Board of Directors that the Committee continue to serve as a truly representative group body elected by alumni. As representatives of the alumni body, the Committee believed that they were in a better position to give careful, in-depth consideration to the selection of alumni officers and proposed that the Board of Directors of the Alumni Association consider amending the constitution and bylaws to provide for the selection of the national officers by the Nominating Committee.

A proposed amendment to the Constitution of the Alumni Association was approved by general vote of alumni on the 1975 Ballot providing that:

1) The name of the National Nominating Committee be changed to the National Selection Committee.

2) Members of the National Selection Committee be elected by the alumni on an annual letter ballot, each to serve for a term of three years.

3) The National Selection Committee select the Corporation nominees and the officers of the Alumni Association (except Executive Vice President, Financial Vice President, Secretary, and Treasurer).

Subsequently, to implement the constitutional change, the Board of Directors amended the Bylaws of the Alumni Association to provide:

1) A minimum of three candidates for each vacancy on the National Selection Committee;

2) Candidates be endorsed by a club in the eligible districts; and

3) The ballot provide opportunity for alumni to make suggestions for future candidates to be considered by the National Selection Committee.

These changes will be reflected in the 1976 Ballot which will contain candidates for National Selection Committee only. The Corporation nominees and national officers selected by the Committee will be announced in Technology Review.

Alumni participation in the balloting for both the annual election and the special election for Representative from Recent Classes remains disappointingly low as reflected in the table below:

<table>
<thead>
<tr>
<th>National</th>
<th>Recent Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3091 3569 3453 3030 2235</td>
<td>1240 1096 665 460 451</td>
</tr>
<tr>
<td>Percentage of Eligible</td>
<td>6.4 7.4 7.0 6.2 4.6</td>
</tr>
</tbody>
</table>
A total of 87 alumni were nominated to fill vacancies on the Corporation Visting Committees, and 17 were elected to serve on the national boards and committees of the Association.

Alumni Fund

The 1974-75 Alumni Fund received a total of $3,327,452 from 21,341 alumni donors. This total was up $409,958 (14 percent) from 1973-74, and represents an all-time record high performance for the Fund. The number of donors was up 432 from the previous year's achievement and ties the third highest performance for donors in the history of the Fund.

The 25th, 40th, and 50th reunion classes of 1950, 1935, and 1925 reported five-year reunion gifts of $780,200, $719,100, and $308,150 respectively. The Class of 1915 reported a special gift of $100,000 for a scholarship fund to be used for student aid with preference for students from minority groups and with special consideration for American Indians and Spanish American students.

Of the $3.3 million reported above, the sum of $138,640 was designated by 1,106 donors for the Independent Residence Development Fund (I.R.D.F.) up $52,872 (62 percent) from 1973-74. A total of $1,190,600 (36 percent) of the $3.3 million was undesignated. The remaining gifts were designated by donors for other specific purposes.

These results were achieved in the context of the five-year plan for the Alumni Fund which seeks to achieve 35,000 contributors and $6.4 million by 1978. Several programs were accelerated. Among them, the number of organized regions in 1974-75 was 161, up from 114 for the previous year. The number of Area and Class Special Gift Chairmen was 45 this year, up from 35. Special projects, such as the I.R.D.F. and the Sailing Pavilion renovation project attracted substantial added support. The state of the national economy made the successful performance of the Fund even more significant.

Last year's reorganization of the Alumni Fund staff on a geographic basis has been highly successful and regionalization will continue. Plans are under way to extend this concept to all programs of the Alumni Association beginning in July, 1975.

A major occupation of the staff during the current year has been to help in the planning of the M.I.T. Leadership Campaign announced in April, 1975. During the five-year period of the Campaign, the Alumni Fund will continue in full operation -- contrary to the conduct of previous campaigns, and all gifts and pledges to the Alumni Fund will be credited toward the goals of the Campaign. Generally, staff support from the Alumni Fund for solicitation programs will concentrate in the area of small and moderate gifts from the broad base of the alumni body, while staff support from the Resource Development Office will concentrate on seeking larger gifts from fewer individuals and organizations.

Ronald S. Stone, '59, joined the staff of the Alumni Fund as Associate Director in October, 1974. Mr. Stone was formerly Assistant Dean and Executive Officer of the M.I.T. Graduate School and before that had been associated with the Institute's Industrial Liaison Office.

Daniel J. Fingerman, '69, also joined the staff of the Alumni Fund as Assistant Director in October, 1974. He came to M.I.T. from a post in the College of Education at Michigan State University.

James N. Phinney transferred to the Office of the Vice President for Resource Development in June, 1975, to become a District Officer for the M.I.T. Leadership Campaign. Mr. Phinney, on the staff of the Alumni Association in its New York office since 1963, has most
recently been Regional Director for the Alumni Fund in the New York area. He has been a highly effective member of the Association staff.

Technology Review

Technology Review has set for itself the goal of providing alumni with a professional journal which can be in some sense a continuation of their M.I.T. experience, but which is so broad in viewpoint that it can also serve non-alumni who subscribe on a "paid" basis. The editorial emphasis is on new developments in technology and their interrelationships with human affairs and the environment in which they are conducted. The year just passed has provided us with some new evidence of our success in this endeavor -- and also of a dilemma with which that success may confront us.

Though one is often frustrated by the media's judgment of newsworthiness, it is nonetheless significant that a number of articles in Volume 77 -- more, perhaps, than ever before -- have been brought to the attention of newspaper readers through accounts in the daily press. Among them were: "Soviet Energy: An Internal Assessment," by Marianna P. Slocum (October/November); "The Earth's Climatic History," by Reginald E. Newell (December); "The Economics of Nuclear Power," by Irvin C. Bupp, Jean-Claude Derian, et al (February); "Petroleum Resources: How Much Oil and Where," by John D. Moody and Robert E. Geiger (March/April); and "The Light of the Supernovae," by Philip Morrison (May).

There also were other important articles which escaped this form of public attention. The material in Kosta Tsipis' "The Calculus of Nuclear Counterforce" (October/November) is now widely cited in Congressional debates; "The Federal Energy Office as Regulator of the Energy Crisis," by Paul W. MacAvoy et al, appeared in the Review just as Professor MacAvoy's nomination to the Council of Economic Advisors was announced by the White House; and Earl Cook's "The Depletion of Geologic Resources" (June) has been published in the Congressional Record.

Surveying M.I.T. alumni on their responses to communications they receive from the Alumni Association and the Institute as a whole, M.I.T.'s Analytical Studies and Planning Group have found ample evidence of the esteem in which alumni hold Technology Review as a professional journal.

Non-alumni "paid" circulation is a by-product of the effort to develop the Review into a professional journal, and the number of copies distributed on this basis during the spring, 1975 (over 17,000) was larger than ever before in our history. By commercial magazine standards this is a small number; but it is only a fraction of the Review's total potential audience. A major goal for the years ahead is to increase this component of our readership; already it seems clear that the Review's influence is out of proportion to the numbers of its circulation. To help accomplish this goal, Kitty Atwood has been appointed full-time Circulation Manager for the Review.

For its unique role as a professional journal with alumni and non-alumni audiences, Technology Review was honored at the end of the 1973-74 year by the Ernie Stewart Award of the American Alumni Council (now the Council for the Advancement and Support of Education). We were cited, with The Portable Stanford, for a "remarkable, indeed unique sense of mission: to render service not only to their alumni, but others as well, by offering intellectual stimulation of uncompromising quality."
Divergent Perceptions

Why, then, a dilemma in the gradually developing success of Technology Review as a professional journal in the fields of M.I.T.'s principal thrust? The Analytical Studies and Planning Group reports that many alumni queried in their survey expressed interest, confidence, and appreciation in Technology Review. Others, whose careers have taken them out of the fields of the Review's special emphasis or those who have retired from active professional work, were less enthusiastic. But in their discussions of communications, many alumni expressed a desire for more information about M.I.T., stressing especially student activities, developments in their departments, the financial situation, athletics, and fraternities/dormitories; in their interests, they excepted only — if at all — formal press releases and official documents as being dull and artificial.

To some extent, it is true that no matter how well existing channels of information function, alumni will seem less informed than we wish; and, if asked how the Institute can serve them better, will respond by suggesting that additional information about M.I.T. would be helpful.

But the survey results lead inevitably to the judgment that, despite these reservations, existing communications about Institute affairs to alumni are seen as inadequate. We are concerned especially because extensive coverage of many of the subjects about which alumni asked has been provided in the "Institute Review" section of Technology Review during the past year or more. One is led to the conclusion that many readers, expecting to find professional content in the professional magazine format of the Review, do not discover the "Institute newspaper" content of "Institute Review." To resolve the dilemma which this conclusion proposes will be a major issue before the editor and the entire Alumni Association during the coming year.

Other Developments

The Review continues to enjoy interest and support throughout the M.I.T. community. We were privileged to publish nine papers -- the entire available proceedings -- from "The New Wave in the Earth Sciences," a conference honoring Dr. and Mrs. Cecil H. Green on the tenth anniversary of the completion of the Green Building. Two papers from a May, 1975, seminar on professional manpower sponsored by the Industrial Liaison Office and the Center for Policy Alternatives are scheduled to come to the Review. Many faculty have contributed articles by invitation, and many more have helped with advice and counsel.

Gregory Smith, '30, chaired a stimulating meeting of the Review's Advisory Board on April 5; discussion centered, as it has often in the past, on the several roles assigned to the magazine with respect to its several audiences, and our insights are clearly greater than they have ever been before as a result of the discussion. Irwin W. Sizer, Dean Emeritus of the Graduate School, has accepted the assignment of Vice Chairman of the Board.

The Review has been strengthened and enriched by the contributions of Dennis L. Meredith, formerly Assistant Director in the M.I.T. News Office. Trained in biochemistry and science writing, Mr. Meredith has contributed as a senior member of the Board of Editors to all aspects of Volume 77. Marjorie Lyon, formerly Advertising Assistant, joined the Board of Editors in September, 1974, to direct the "Class News" section of the Review with distinction and imagination.
Staff Changes

During the past year, several staff changes were made within the Association. Most notable among these were the retirement of Donald P. Severance as Executive Vice President of the Association and Publisher of Technology Review. As Executive Vice President, Mr. Severance served the Association for 12 years. Prior to that, he served as Secretary and Treasurer of the Association for 13 years. Mr. Severance oversaw substantial growth in both alumni relations programs and the performance of the Alumni Fund, and as Publisher of the Review, the advancement of the magazine to a place of prominence among technical and alumni publications. Upon Mr. Severance's retirement, the Editor of the Review published the following testimonial:

... Careful observers of our masthead will note that Technology Review now has a new Publisher; hence the Editor's use of this space for a brief note about Donald P. Severance, who has joined the M.I.T. administrative staff after having been Publisher of the Review throughout my tenure as Editor. No editor could have asked for a more thoughtful, generous, and judicious associate; only other editors, perhaps, will understand my full intention when I write that Mr. Severance was always -- and in every way -- an editor's publisher.

The Institute, however, will continue to have the benefit of Mr. Severance's services as he continues in the position of Director of the Volunteer Leadership Appeal for the Resource Development Office.

On January 1, 1975, James A. Champy, '63, assumed the post of Executive Vice President of the Association and Publisher of the Technology Review. Mr. Champy returns to M.I.T. from private practice as an attorney.

During 1974-75, the Association and M.I.T. had the benefit of the services of Luis Ferré, '24, as President of the Association. Mr. Ferré devoted considerable time and energy to the work of the Association, exemplifying the work of 3,000 volunteers whose efforts primarily contributed to the success of the Association's programs. Mr. Ferré's extraordinary energies and insight have carried the work of the Association and knowledge of the Institute to many new audiences. Mr. Ferré leaves an enriched presidency of the Association to be assumed by Howard L. Richardson, '31. Mr. Richardson has been active for many years in Association programs and brings the respect of alumni volunteers and Institute staff to his leadership role.

JAMES A. CHAMPY