

William R. Dickson Oral History Project  
Interviewer: Peter Cooper  
March 2, 2005

X: Today is Wednesday, March 2nd, and this is an oral history of MIT given by William R. Dickson, and today's interviewer is Peter Cooper.

WD: Well, I thought what I would talk about today is the general subject of utilities. And I should start off by saying that when the Institute moved to Cambridge in 1916 as well as the main group of buildings that formed the first part of the Institute, they also built what we always called the power plant. And so the plant that is on Vassar Street, the yellow brick portion of it in the stack, was basically constructed in 1916 in order to supply steam and electricity to the Institute. There's a walk-through tunnel that comes from the plant on Vassar Street, passes under Building 37, which, of course, wasn't there at the time -- under 31 and I think through 13 and ends in a head house over by Building 10. So originally that tunnel just extended from Vassar Street to Building 10, you might say. It provided low pressure steam for heating. It provided about 1,000 KW for electricity from steam. And I believe it must have had a higher pressure boiler also in order to produce the electricity from a steam turbine. So I guess you could say that we started out with a cogeneration plant, and it lasted for quite a while until I think the first segment went by the boards was the electric power generation because it became such a miniscule part of what the Institute came to use, particularly during World War II. The fuel at the time was coal, and there was a big coal pile behind the power plant and adjacent to the railroad tracks. And that coal was the source of fuel until just before World War II, when the Institute converted to the use of oil for heating; however, the war came along and oil was a precious commodity so they had to switch back to burning coal. And so they burnt coal until the end of World War II when they for the last time switched to oil and were able to burn gas also -- interruptible gas when the price became significantly attractive. As air conditioning became more popular after the war, three of the buildings built first -- the Green Building, the Whitaker Building and the Bush Building -- had their own air conditioning machines. The Green Building had a Carrier machine, the Whitaker building had two York machines and the Bush Building had two Worthington

machines. It soon became apparent, however, to my predecessor, Carl Peterson, that this was really not the way to go in the future. And so plans were developed to build the first part of the air conditioning plant, central chill water plant, I guess it was called in the power plant. This was done by reorganizing the plant and providing space for three machines I think, two larger machines and one smaller that totaled around 10,000 tons. Of course, it was felt that you'd get a lot of diversity And so that by having a central plant, you would have less installed tonnage. The three machines I spoke of in the Bush, Whittaker, and Green Buildings were all electric driven centrifugal machines. And by the time the student center came along, though, we used a steam absorption unit as we did when we used the Hermann Building. We built the steam absorption unit because we still didn't have a supply of chilled water, particularly for the student center, and also because we did have steam across the street. And ultimately that absorption machine was replaced, and it is now fed by chilled water from the central plant. Absorption machines were difficult to run. I don't know whether everyone had this difficulty or whether we were the only ones who had it. But the lithium bromide solutions seemed to solidify at times and of course the machine would stop, and it would have to be restarted, and it took a fair period of time to get it back up to speed.

INT: One thing that I could add is that these centrifugal chillers in the central plant were powered by steam, and you had plenty of steam capacity because of the boilers available. I suspect it would have required an investment in electric system to power all that capacity electrically -- so it used the available capacity, which was steam.

WD: You're exactly right. They were steam driven centrifugal machines, which were somewhat different than the electric driven centrifugal machines that were out in the buildings. We were eventually able to replace the Worthington machine and the Carrier machine and the York machines in those three buildings that I spoke of with chilled water from the new chill water plant. This, obviously, meant that we had to start producing a network of piping in order to get to these facilities and then, hopefully, further on in the future. I think the only air conditioning machine in place at the time was a small one in the Hayden Library and a larger one in the Sloan Building, which was water cooled by river water. We'll get to that in a minute. So

that the original scheme -- I don't know whether it's the final scheme -- had basically three trunks of the main campus; one sort of on the eastern part of the campus, one sort of down the middle, and one on the western part. Originally, I think, there wasn't a great deal of planning to go across Massachusetts Avenue or to go across Ames Street. The architect of all of this -- if we can use that word -- was really Carl Peterson, the Director of Physical Plant, and then maybe called Buildings and Power. Carl was very knowledgeable in the utility area and, as a matter of fact, his father had been the chief engineer at the power plant. So as a young fellow he used to work over there shoveling coal and doing other things before he became Director of Buildings and Power in an emergency. The emergency was that the current director, I believe, hung himself in the drafting room, and they were looking for someone to fill in the void for a short time until they searched and hired someone. And that was, I believe, in the late '30s, and Peterson stayed in that position until he retired in 1971.

One of the other principals involved in this was Dick McKay, an engineer, a graduate of the Institute, who we hired in the early '60s. He spent a good amount of time and effort working with Mr. Peterson in the design of the plant. On the other hand, I'm sorry to say that at this point in time I can't remember who designed the plant. We obviously had someone from the outside, and whether it was [Syska & Hennessey] -- it could have been, but I frankly don't know. I can't remember. The low pressure steam that came to heat the Institute -- again, the old buildings, came through a very significant size main in the steam tunnel. And it used to supply heat to the main group radiators and probably was the source of warm air to the DC fan units, large DC fan units, that pumped air for ventilation throughout the Institute. There was, of course, no air conditioning at the time. The original power supply was 2,300 volts generated at the plant, and it was eventually supplemented with services from Cambridge, most of which I believe came in at 13.8 kV. So the thirteen/eight system, which eventually became the primary system of the Institute, was gradually developed and now, I believe, serves all buildings on the campus. The 2300 volt system was gradually phased out and there may be something left, although I'm not sure that's the case. Do you know, Peter?

INT: It's still in service especially for the power plant auxiliaries -- but also the main group buildings are still fed from the 2,300 volt system. The emergency generator in the plant that serves as main group emergency power is also at 2,300 volt. So it's still very much in use. We are not actively abandoning it, although when choice comes we put new buildings on the 13.8 kV system.

WD: I cannot remember building a building during my time where we used 2,300 as the primary power. There may have been one, but I can't remember it. It seems to me we always brought in the new thirteen/eight and most of the transformers we purchased were thirteen/eight to either 120/208 or in some cases the 277/480. In time, as we developed more of the East Campus, the first buildings that we developed other than the Sloan Building was the Ford Building complex. And we put electric driven centrifugal machines in that complex and over time when we occupied the FS Webster Building -- FS Webster was a printing company, Building E40, we built a satellite chill water plant in what used to be the boiler room for the Webster Building. We eventually went down and took out, I believe, the steam absorption machine from the Hermann Building and the old machine from the Sloan Building and fed them with chilled water from this East Campus satellite plant. That plant was an interesting design. Of course, we had to have cooling towers, and there was quite a ruckus about whether we could put cooling towers on the top of the Webster Building because it was directly opposite 100 Memorial Drive and some of our primary people lived at 100 Memorial Drive and expressed some reservation about the view to the north with this large cooling tower structure in place. We eventually prevailed. The cooling tower structure is there. We were able to put in a satellite plant in this basement space, although the first attempts said you couldn't do it because there wasn't enough room. We tried some other alternatives, and I finally said you've got to make enough room because that's where it's going. And lo and behold through some magic, there suddenly was enough room, and the plant was constructed. It was not intended to be a plant with people. They may check in on it once in a while, but it was to be a plant that basically by telemetry would send signals back to the main plant and could be operated basically remotely. As far as I know, that's the way it operates until this day. And I don't believe I can ever remember having a significant

amount of trouble in operating the plant this way. The one thing I'm unsure of at this point, and perhaps Peter can fill me in, is whatever happened to the machines in the Ford Building. I know when we built the satellite plant we didn't just automatically run up the street and pick them up. We left them in operation. And I don't know whether they're still in operation. Can you tell me, Peter?

INT: They were removed. And I remember doing the asbestos abatement and so on in that area just as I arrived in '97. Also, when the tunnel was built underneath Ames Street from the Biology Building that afforded some new piping to come across, and I don't know if that was related, but the timing was about the same time.

WD: So is it fed now from the central plant on Vassar Street?

INT: It is. But it can be fed from either the East Campus plant or the central plant. There is also some larger piping newly installed for the delayed Media Lab expansion which connects the two plants. We are changing pumps in the East Campus plant so the two plants can run in parallel with one another. We will have the flexibility to provide backup in case of failures and economically dispatch between the two plants.

WD: There's a couple of interesting points that I probably ought to bring up about the plant, the original power plant. One is that when we had the Northeast power blackout which was in the '60s -- I don't remember.

INT: November 9, 1965.

WD: Of course, Bill Coombs and I were working in the Ford Building, and the power went out. And after the obligatory "God damn it; I wonder what's wrong," we made our way out of the building. I think the emergency generator had probably come on, and lo and behold, when we got to the bottom of the stairwell and stepped outside, not only was that building not lit, nothing was lit in Cambridge or Boston. So we realized there was a larger problem -- when we first figured that it was probably a local outage that somehow affected that building or a few of our buildings. Cambridge Electric, of course, lost its boilers and lost its ability to generate any power. It generated some of its own power at the time and imported the rest. But it couldn't even generate its own power. So one of the older boilers at our plant was lit off by hand and we generated enough steam to get our steam generator which is still in place to back feed into Cambridge, and they were able to start up at least some portion of their plant by the

back feed that we made available. Obviously, once they got part of their plant up, then they could back feed themselves to other parts of the plant. So the Institute provided the impetus for the first power to return from Cambridge Electric.

The other thing that happened in that -- a little later era -- around '73 or '74 was the Arab oil embargo, and the Institute was worried that it wouldn't have enough oil to operate. And of course, if you remember the dire predictions at the time, there would be perhaps not enough oil, and natural gas was going to run out of reserves by the late 1900s. And we decided it was time to look at cogeneration, again. I say again because we actually had it at one time. And we spent a long time studying a coal burning cogeneration plant. Coal burning because that was the fuel that there obviously was a lot of, and we controlled our own coal as opposed to having to buy it from foreign countries. There were three basic problems -- actually, we went quite far with this study in-house. First problem was transportation of the coal to the middle of Cambridge. It certainly could be done. There was a railroad right there. But coal as a shipped commodity in this area had stopped quite a while ago. So that was one thing that probably could have been overcome; however, we had such capacity that we would have had coal cars lined up over there for a long period of time. And secondly, we needed to have a capacity to store coal, and it just didn't seem right anymore to make a big coal pile in the heart of a developing campus. So we decided to use silos. And we designed a scheme with several silos where we would transport the coal in, load into the silos and then use the coal from the silos to feed the plant while reinforcing the coal in the silos by more being brought in by rail. And of course, the third big obstacle was the proliferation of controls of the environment. And while it probably would have been possible, it didn't seem too practical to try and fight the battle of the coal system as far as the environment went. And we looked at other alternatives. Peter, you're going to have to help me. There was a method of coal burning that came along that some people used that was supposed to be cleaner.

INT: Was it fluidized bed?

WD: That's it. Fluidized bed.

INT: University of North Carolina has it. That's a good technology.

WD: What was the principle of the fluidized bed?

INT: Instead of blowing pulverized coal into the furnace, a coal and limestone mixture is burned in a stoker bed with air coming up through it from below. It performs much better environmentally than the pulverized coal.

WD: Is it still in use?

INT: It is. Yes.

WD: In any case, we abandoned the use of coal, and as everyone knows eventually returned to build a plant that used gas as a principal fuel with the ability to use oil in the short term. That meant we had to build a new gas line from Cambridge Gas Works which used to be over on First Street, I believe, and supplement the supply significantly. Prior to then, we had just burned interruptible gas. Eventually, we extended, I believe, the chill water line to the student center, and I think that may be the only place on the other side of Mass. Ave. that we used chill water for the plant. Is that right, Peter?

INT: Also, Kresge Auditorium.

WD: I'm sorry. Right. At the same time -- we picked up the old machines that were under the grating outside of Kresge Auditorium.

INT: Subsequently the Johnson Athletic Center and new Z-Center are served from that system. So that whole complex is now fed -- even the chapel -- from the central system.

WD: What we didn't do is we never went over to Albany Street.

INT: We now have extended chilled water lines down the railroad right of way. So there are additional buildings that have chilled water service like the Plasma Fusion NW21, NW30 graduate residence and Simmons Hall.

WD: The use of the cogeneration was, of course, again, a big problem design-wise. We had a considerable amount of environmental permitting problems with that. And I guess, eventually, came up with a low NOx solution with the help of Professor Janos Beer of Chemical Engineering that allowed us to permit the plant and of course we used one large machine from Sweden -- what's the name of it, Peter?

INT: The company at the time was ABB. They were subsequently bought by a French company, Alstom, and now they're owned by the German company, Seimans.

WD: The process of selection was between them and General Electric. And General Electric was a significant contributor to the Institute over time, as some of its higher level employees -- very good supports of MIT. So we had a long look at whether we should use the GE machines and decided that the ABB machine was a better product. It was put in place, and as you might imagine for the first six months or so there was some problem. I think at one time we even had a defective turbine blade, which made us shut down and replace the blade. But to my knowledge, and Peter can tell me better, in the past seven or eight years, it's been a fairly effective operating system. It supplies around 20 MW, and I understand our load, which was 25 when we built it, is now approaching 35 when the new buildings now in construction go into place.

INT: You're right. It's a 20 megawatt unit, and we're approaching 35 megawatts on the central system.

WD: The question I, therefore, would say, is it a good enough investment so you ought to repeat it and build another unit? And I don't pretend to know the answer to that.

INT: Well, the utility engineers who have looked into it and run the numbers are absolutely convinced that it's the right thing to do. We should be putting in cogeneration and make electricity and steam together. Environmentally, it's a much better thing to do as well.

WD: Do we need more of steam now?

INT: Yes. We do. We have a couple of packaged boilers in our parking lot temporarily. That's how bad we need the steam now.

WD: Well, in the long-term economically, it probably would be a smart thing to do.

INT: We think so.

WD: Who is not convinced?

INT: Well, it's expensive. It's another \$40 million investment -- similar cost as the first cogeneration project, and \$40 million is hard to come by right now at MIT.

WD: Will you use another Seimans machine?

INT: No. I don't think so. We'd use, probably, a US domestic machine instead.

WD: Who makes them besides GE?

INT: There is a good competitor in this turbine size, Solar, which is a Caterpillar company. It's a company that developed selling to the navy in San Diego and have thousands of machines out now. So it's a proven and well-supported machine.

WD: What's in place now for emergency power?

INT: It's similar to what was there before. We replaced the old Waukashaw diesel generator as a Y2K mitigation. And we replaced it with a new generator in the same location but about double the size. So we have a 2 megawatt emergency generator. But the codes now require the life safety power on new buildings to be supplied by generators at the buildings.

WD: Oh, they're back to that?

INT: Yes. But all the existing buildings in the main group are still on this grandfathered emergency power system.

WD: The Stata building has its own generator?

INT: That's right.

WD: Are we using air cooled or water cooling generators?

INT: Air cooled. Again, the city does not allow water cooled machines or gas fired machines, either. So it needs to be oil with associated tank storage, and air cooled machines for life safety.

WD: It seemed to me that we had a lot of trouble in the blackout with air cooled machines - - that they got overheated. Why are they against water cooled machines?

INT: They say water is just another outside source. They think that natural gas and water have to be provided by the outside utility, and therefore are less reliable than a tank of oil. I'm not sure if I agree with them.

WD: How long would you be able to run a machine typically?

INT: With the oil that it would have locally stored -- from a few hours to maybe even eight hours or something of that nature -- two to eight hours timeframe. Then we'd be refilling oil with a truck.

WD: The other problem I think of when I think of utilities is the distribution of high pressure steam. We used to build tunnels, not walkthrough, but concrete tunnel with a concrete cover underground. They were fine until the return line which is usually what fails -- failed, and then we'd have to dig them up, and it became quite a job --

either that or try and work through a manhole and thread the pipe, which was not an easy job. I think we then went to direct burial and of course it had its problems too. I don't know if it's better today than it once was. Do you have an opinion on that, Peter?

INT: Yes. The first generation of direct burial has not lasted very long.

WD: That was Rickwill?

INT: Yes, Rickwill. The next generation is more expensive, but it's more highly engineered, and we have used it in high hopes that it will last a long time.

WD: Where are the weak spots now on the campus, Peter?

INT: The weak spots are with the steam distribution system at the very west end and the very east end -- there's only a single source as opposed to a looped supply. So we're exposed there. We have beefed up the electric system so that we can take more power from the NSTAR Electric if we need to.

WD: We took over the Cambridge Steam Company's steam line on the East Campus, right?

INT: That's right.

WD: They used to supply the Sloan Building, and had a line up to 100 Memorial Drive right up to Ames Street, I think.

INT: That's right. We're still using that line.

WD: And we took it over from them?

INT: That's right. And we used to be able to buy steam if we needed to from the far end -- the original supply. But the Cambridge Steam Company let their equipment deteriorate to the point they couldn't operate it anymore. So that alternate supply is no longer there.

WD: They're selling steam from the Blackstone Station to Harvard. But did Harvard buy the Blackstone Station?

INT: Harvard bought the Blackstone Station as a defensive measure. They were concerned that the reliability of the plant was going downhill. I think they now know that that was the case. And they're investing in the station.

WD: What else should we talk about as far as utilities go?

INT: Well, one thing you may know about is the cooling water system that comes into the main group and ultimately went to the power plant and that doesn't get much attention. So it would be good to record your knowledge.

WD: Are you aware that there's a stop log manhole out there in that system?

INT: And trash screen and so on. Yes. Right at the edge of the lawn of the great court.

WD: Does anyone ever look at it?

INT: Not to my knowledge.

WD: Do you know why the stop log manhole was put in?

INT: Well, I assumed it was because if you thought there was going to be flooding in the Charles River --

WD: Right. Because we once had a significant flood in the '50s in the main group -- probably a couple of feet of water. Of course, since that time the dam has been changed, and the only way it would happen now is if the timing of everything got so out of whack that they couldn't dump the river. So that's when the stop log manhole was put in. We used to test it quite frequently. I remember it wasn't easy to test. But in a previous conversation out here, I reminded Vicky that that was there and that she ought to at least inquire to make sure that people knew that it was there.

INT: We investigated it a few years ago when we were concerned about a possible spill of chemicals or oil in our buildings getting down into that system and possibly going into the Charles River. So we paid attention to it, actually, for that reason. It still does convey storm water from the main group out to the Charles River. So it still has a function.

WD: Is the trash rack in that or in another place?

INT: It's in the intake side which is no longer in use. It's not used for cooling anymore. I think the last use was at the Combustion Lab, Building 31 where they used the water to cool a gas turbine experiment.

WD: We also used to use it for Building 13 with the Worthington machines. There were no cooling towers. And I think we built another trash rack right in that court because we were having so much trouble.

INT: Building 13 is now on the central chilled water system. A river cooling water system which still operates is the one which served the Magnet Lab. It operates now only to cool the Plasma Fusion Lab equipment.

[End of interview]