INTERVIEWER: Today is December 14, 2009. I am Karen Arenson. We are talking with Joel Moses, who earned a PhD in mathematics at MIT, and whose interests over the years have focused on computer science, artificial intelligence, and engineering systems. He started his career as a professor in Course 6, which, at the time was called electrical engineering, and is now electrical engineering and computer science. He became head of the department, dean of the School of Engineering, and MIT's provost. He is currently one of only 14 Institute Professors and is acting director of the Center for Technology, Policy, and Industrial Development. Joel, thank you for talking with us today.

You've described your life as inextricably entwined with MIT. What do you mean by that?

MOSES: Well, I came to MIT in 1963. That was the third time I actually applied. I couldn't come here as a freshman because we couldn't afford it, unfortunately. And then, when I was graduating, I applied again and I made the mistake of accepting a fellowship at Columbia, rather than a research assistantship. And then, finally, I saw the light and I came here in '63 and I've been here ever since. When I applied for faculty positions in '67, about to finish my PhD thesis, one of the department heads said, "Can you cut the umbilical cord to MIT?" I guess I haven't. I just couldn't. It's been so great.

INTERVIEWER: What made it a good match? Is there something about the chemistry between you and this particular research university?

MOSES: That, I don't know, but what was amazing about the situation was I didn't think much about what I was doing. Things were fun. Math was fun. Doing computer science was fun. I didn't really start thinking about -- what was I doing? What's been my goal? What have I accomplished? -- until I became department head in 1981. So, it was a tremendous ride.

INTERVIEWER: Did it remain fun all along the way? Or were some things more fun than others?

MOSES: Yeah, I mean, most faculty don't particularly care for administration. I happen to like it more than most. But there are times as an administrator that are tough and not as interesting, if you will, as others. But I found even administration, especially committee work, which most people don't like, I found that interesting.

INTERVIEWER: Why?

MOSES: Well, I don't know. There's some times you get ideas in the process of a discussion that goes on for a while. You really get at the essence of issues, surprisingly, and ideas come forth that you wouldn't have expected. And that's happened to me on several occasions while I was an administrator.

INTERVIEWER: But, they're usually different kinds of issues from the ones you worked on as a scientist or mathematician.

MOSES: Yes, indeed, the administrative issues. But, nevertheless, I've found it interesting.

How did I get into administration? Well, it's almost a trap. You have early success and you get excited about doing more for the Institute, for the department. I've had early success.

INTERVIEWER: Tell us about the path before you got to MIT and what led you here. Where were you born? What was your childhood like? Your family?

MOSES: I was born in Israel -- well, at the time, it was called Palestine -- two weeks before Pearl Harbor. And I lived, for the first five years, in a village of farms. So I was born on a farm, if you will. And, my parents were not great farmers. In the midst of World War II, they came to Palestine from Germany. My father was a businessman. He was very successful in Germany. And so, he, basically, became a businessman for the farm community. He sold the produce better than anybody else could sell the produce in the nearby city called Netanya. After a while, we moved to Netanya in 1946 -- 1947, I think -- and we lived there until 1954. Netanya, when I left in '54, had a population of maybe 30,000. Now, I think its population is about 200,000. It became a major place for people to vacation.

In any case, ah we left in '54. Arrived here on September 1, 1954. Actually, we were supposed to arrive on September 2, but the Israeli captain thought that since July had 31 days, August must only have 30 days. So, we quickly had to telegram everybody waiting for us that we'd arrive a day earlier on September 1. In any case, we wound up in Brooklyn, New York and stayed there for a number of years going through junior high, high school, and then at Columbia College.

INTERVIEWER: What was it like to come to a new country? Did you find it exciting or frightening or?

MOSES: Neither exciting nor frightening. Much of it was, sort of, surprises. My mother decided to prepare me for coming here. She bought me ten pairs of pants that were short. Well, in the '50s, we didn't realize that the kids in Brooklyn weren't wearing shorts. So, that was a surprise. I didn't speak the language much at all, so I had to learn a lot. That was difficult -- took about nine months before I was reasonably acclimated to the language. A lot of things were surprising-- we didn't have supermarkets in Israel. You had to go to a milk store, you had to go to a meat store. Bakery shop -- that was what people expected to do. Here, it was all in one store. Big surprise.

INTERVIEWER: Do you think coming to a new country shaped your willingness or ability to deal with new experiences later on? Or approaches to creativity or research or anything or?

MOSES: It's possible. I don't know. What I think, as I reflect back on what shaped me, it was my parents' background, more than anything. My father was born in Germany and stayed there until they left in '39. My mother was actually born in Romania and left Romania as a result of World War I. Wound up in Berlin. That's where she met my father in '38. Their attitudes toward family, toward, actually, problem solving -- I didn't realize that -- that had a major impact on me. Possibly more than my 12 years or so in Israel. Again, yes, everything shapes you, and I was shaped by all of these countries. But, the surprise was how much my thinking was affected by my parents' German background.

INTERVIEWER: And how would you characterize your approach to problem solving?

MOSES: Well, problem solving and organization -- a little more hierarchical than the American classic approach. In any case, a different kind of hierarchy. In the '50s and later decades, most American thinkers about organization thought in terms of what you might call a tree structured hierarchy, where you have a president and vice presidents et cetera, et cetera. There is more of what I call a layered hierarchy, in thinking of Germans. It goes back, in some ways, to the Middle Ages. That approach to organization and also problem solving, it turns out, had an impact on me and makes me different from a lot of people in this country at this time.

INTERVIEWER: Were you always drawn to science and engineering? Or when did you first, as you think back, when did you first recognize that you might be? That you like these subjects or were good at them?

MOSES: I realized that early on. In the fourth grade, when the teacher had to leave town, they had me grade the papers in the class. Math came easy for me. It was enormous fun. In fact, I was on the math team in my high school. I went to a regular high school. It wasn't one of the exam schools in New York. Stuyvesant, Bronx High School of Science, Brooklyn Tech, were the exam schools. I went to Midwood High School. But in the competition, we beat Bronx High School of Science. A real surprise for them, I suspect. It was fun and we worked at it. Every lunchtime, in addition to eating lunch, we would solve problems.

INTERVIEWER: You and your classmates?

MOSES: Yeah, and the team members, yes.

INTERVIEWER: But, did you have a faculty member who sat with you at lunch and threw problems at you?

MOSES: Aaron Shapiro was the faculty member who was in charge. And I just read about him recently. You get all this information, now, on the Internet. He was treasurer of the American Math Association branch for all of New York for many, many years. He was wonderful. Really, a great teacher. I had him, not only for the math team, but also for calculus later on.

INTERVIEWER: Did you think you would become a mathematician at that point?

MOSES: No, because my parents convinced me I was supposed to become a doctor. And why that? Well, my father's cousin, he was a famous doctor. He was one of the leading doctors at the Hadassah Hospital in Jerusalem. He created the rabbit test for pregnancy and became very well known as a result. Certainly, in that generation. Young people don't seem to know about that. And then my mother's brother became a doctor. I once asked him, Uncle Sam, -- that was his name -- how did you learn seven languages? He says, Oh, that was simple. I got thrown out of six countries. In the process of leaving Romania, then Germany during World War II, he wound up in a number of countries. He learned a language in each one.

So, basically, I was supposed to be a doctor. When I went to college, they didn't have a pre-med major. So, you have to put down a major. I did what was easy; I put down math. Then, next year, I put down math again. Finally, I said, this doesn't make any sense. I'm not ever going to be a doctor. I'll be a mathematician. And then, I wound up being a computer scientist.

INTERVIEWER: Did the medicine part really attract you at all or?

MOSES: Well, I hadn't really thought about it much, as it turns out. Nowadays, actually, we do research in my center on health care policy. So, it's a turn around, if you will. But math was just too attractive, easy, and computer science was even more attractive and even easier, in some ways. So, I really went for it.

INTERVIEWER: What was your life like as an undergraduate at Columbia?

MOSES: Well, actually, I lived at home. We couldn't really afford for me to live in the dorms. What makes Columbia different from MIT is that a large number of required subjects in the humanities. And you have to think about Plato and Aristotle, music and art and things of that sort. Probably more so than MIT students really tend to do. That's the difference that I find between Columbia and MIT. On the other hand, when I came to MIT, I was blown away by the level of work in mathematics and in computer science. It was just much, much higher level than I was used to at Columbia. So, I came to the right place for those fields.

INTERVIEWER: Finally.

MOSES: Absolutely.

INTERVIEWER: Did you imagine yourself becoming a professor when you were in college? If medicine wasn't it, did you begin to try to think about what might be your career path?

MOSES: No. It just fell in place to me. For example, my last year of doing a thesis, I didn't apply anywhere. I got these calls. How would you like to give a talk at Carnegie Mellon? How would you like to give a talk at Bell Labs? How would you like to give talk at Stanford? The head of the department at Cornell called, said, "I guess you're not really thinking about us, but if you are, Cornell would be a good place to go." Basically, I gave talks everywhere but I really didn't think about a faculty position much until I was in the corridor one day and Bob Fano, who was running the lab then, Project MAC, computer science lab, said to me, "I hope you'd stay as a faculty member." Oh, okay. That was it.

INTERVIEWER: Interesting. When did you first encounter computers and was it love at first sight?

MOSES: First time I saw a computer was in 1957, I would guess. I got a job in the summer at Wall Street. I was a runner.

INTERVIEWER: So you were still in high school?

MOSES: I was still in high school. I was a runner. But they gave us a tour of the place and I saw this big, humongous machine with a huge amount of hot air being blown away, et cetera. And they told me what it did was it added and multiplied. That's all it did! This humongous machine. And I was fascinated by this idea. Nothing much happened until about 1961, when I was able to take a course in programming. And boy, that was fun! Enormous fun!

INTERVIEWER: You were in college then?

MOSES: Yeah, now I was a third year in college, but it was actually my last year. I graduated early. And I guess I did so well, they gave me a job working in the center, there. Working for IBM on weekends and then during the summer. And that's how I got into it. So, I moved from mathematics to computer science just because one was more fun than the other.

INTERVIEWER: And did it strike you, at the time, that this was a burgeoning field and that maybe you could make your way in it?

MOSES: I don't think so. I wasn't planning in those days. You just went with the flow. You went with what was most interesting. So, what happened was I got the idea after I graduated college and while I was doing my Master's. I could combine the mathematics and the computing by using computers to do mathematics. And I read a PhD thesis done here under Marvin Minsky at MIT, by a student, Jim Slagle, who did a PhD thesis on doing integration problems in the calculus. I read it and I said, gee! I could do better. I think I should go work at MIT, work for Marvin Minsky, and redo that, building on what Slagle had done.

INTERVIEWER: And you were an undergraduate when you were --

MOSES: I was an undergraduate when I first heard about it and then all through my next year, into my Master's year, I was thinking about how I would go about doing it. As it turns out, I didn't do anything like that. Not what I'd planned, initially. But it was the same topic: integration problems in the calculus.

INTERVIEWER: And so, for your Master's, you were still in the math department at Columbia working on what kind of problem?

MOSES: Well, basically, no problems. You have to do a number of courses and then at the end of the year, they gave you an examination to see whether you could go on to the PhD or did sufficiently well to get a Master's. The department head saw me in the corridor and he said, "We stopped grading the exam when we decided that you did sufficiently well and that's because we know you're leaving." So that was the end of that.

INTERVIEWER: They knew you were going to MIT at that point.

MOSES: Yes, they knew in May of that year that I was leaving.

INTERVIEWER: When you moved to MIT, though, you stayed in the math department.

MOSES: Correct.

INTERVIEWER: Why?

MOSES: Well, the options were going into electrical engineering, which was building up its computer science at that point, or in the math department which had some computer science but not much. But since I had degrees in mathematics, I figured I could do the required courses and examinations in mathematics. If I'd gone to the electrical engineering department, they would've asked questions about electrical engineering, which I wouldn't have been able to answer. So, the math department was quite flexible and it was a great experience because pretty much, what I wanted to do, they let me do it, and I enjoyed myself.

INTERVIEWER: Were the professors in the math department aware that you and maybe others were increasingly interested in the computer science field? Did it show? And did they care?

MOSES: Well, Minsky was in the math department for a while, then he transferred over to electrical engineering. So, they obviously knew that. At some point, they appointed Seymour Papert in the math department, so they knew that they needed to build up a little bit. But it didn't become a major issue, as far as I could tell, until the mid '70s, when Ken Hoffman was department head and he felt that he needed to build up theoretical computer science. And he did so, slowly. And now, they have a very strong theoretical computer science program in addition to the theoretical computer science program that we have in the EECS department. So, they all work together in our CSAIL laboratory -- Computer Science and Artificial Intelligence Lab.

INTERVIEWER: But in two different departments.

MOSES: But in two different departments.

INTERVIEWER: Is that an effective way to go about it? Are there pluses and minuses to doing it that way?

MOSES: It works for us. It really does. I remember once asking the guy who's currently head of the math department, who's a theoretical computer scientist. I said, "Why did you go to math instead of EECS?" He said, "Well, when I interviewed in math, the head of the department was so relaxed, he fell over in his chair." He said, "Any department where the department head is so relaxed, that's the department I should join!" Now, he's head of the department.

INTERVIEWER: What were your first impressions of MIT when you came here?

MOSES: Oh, jeez, this place is tough! It's so much harder. The level of the courses that I initially took in mathematics was so much higher than what I was used to. So, I started immediately taking courses in the EE department, where the computer science courses were. Things that I could handle reasonably well and I enjoyed. And the math department allowed me to take a number of computer science courses in the EE department as well as math courses in mathematics. And so, my first impression was, tough! Oh, my God, am I going to be able to do this? But then, later on, it turns out, it was okay. It worked.

INTERVIEWER: How many of your classmates came in with the same reaction you did? If everybody, or almost everybody, came from the outside, did they all tend to feel, "Gee, this is hard!?" Or were most of the students from MIT, and so they were just going along? It's interesting that you would have come from a very good university and have that reaction.

MOSES: Good point. I didn't know many. Some of the ones I did know in the math department who were Columbia graduates, had an easy time of it. They picked up a field, a subfield, in mathematics and did a PhD within two years, even. So, I can't say what the general impression was. I just didn't know that many graduate students in the math department. So, I can't really say.

INTERVIEWER: What did you do your thesis work on?

MOSES: Eventually, it took a while to convince Marvin Minsky to allow me to do it, but I redid Slagle's thesis using more mathematics to start with. He was, I think, trying to see if he could, in a sense, do it the way freshmen did it. Well, I was trying to see if I could do it the way expert mathematicians did it. So, I read up the literature, which was reasonably -- well, not fully developed -- on how to think of this as a mathematical problem. And then, I did a computer implementation of that.

INTERVIEWER: Which was to use computers to --

MOSES: To do a symbolic integration. And, not the way freshmen might do it, but the way experts might do it. Maybe even better, in some cases. Later on, we figured out how to do it in a way that surprised professional mathematicians.

INTERVIEWER: And why did that question interest you? Did you feel like it was important? Or, what about it tugged at you?

MOSES: It combined my various interests. So, on one hand, mathematics, and the other hand, programming, and the third could be viewed even as AI, or at least initially, was AI -- artificial intelligence. So, by combining all three into that one problem, yeah, gee, it seems like a good thing to do.

INTERVIEWER: Artificial intelligence became one of your strong interests. How did you get into it? And, where did you think you would go with it? What about it fascinated you?

MOSES: Well, Minsky supervised the first thesis -- Slagle's thesis -- on integration. And so, I went to work for Marvin. He was one of the fathers of AI. There are, essentially, four: Minsky, McCarthy, Herb Simon, and Alan Newell. So, I took his courses and I learned about AI from him. And, I tried to advance that part of the field as well as understanding of integration and build, if you will, a mathematical laboratory so that engineers, scientists, could use it to solve their problems. So, it had a useful aspect to it. It had an AI aspect to it. It had a mathematical aspect to it. All combined.

INTERVIEWER: And, the feeling that it was sort of a technical step by step approach as opposed to sort of being fascinated in some grand way about what machines would do in the world or sort of not a science- fictiony love.

MOSES: No, it wasn't science- fictiony. This was real, practical stuff. Now, I have to tell you, there was another graduate student of Minsky's in the EE department, Bill Martin, who was working on creating what he called The Symbolic Mathematical Laboratory, which allowed us to understand and work out step- by- step processes that engineers or scientists might use in order to do symbolic calculations. So, we had to differentiate and integrate and simplify and all kinds of things that people do. And, he was working on the step by step process. He was also working on a beautiful display of expressions which didn't exist at the time. And, I was working on differentiation, integration, a little bit of simplification on my side. And we combined forces after we finished our theses.

So, we had a very practical aspect to it. In addition, of course, the rest of the Marvin's students were mostly interested in the larger issue of artificial intelligence. And, I was, too, but I parted company a little bit from Marvin's approach partly, now, I think, because of my German background, because I created what was, later on, called expert systems or knowledge based systems. And, that was a different approach than the one that was initially used in AI. AI, at the time -- say, mid '60s -- the feeling was that you had to solve a problem by not knowing much about it and just looking at the statement, some axioms, et cetera. Do it very logically. Work out the details, et cetera, et cetera. I said to myself, "This is not likely to work on hard problems." Are you going to be able to re-derive Einstein's Theory of Relativity without knowing something about physics and some of the experiments that people have done? I didn't think so. I thought you really have to know something. That was a surprise to people, I think, to people in AI. I pushed that for a while, but then I dropped out and I became more of a pure computer scientist.

INTERVIEWER: To what extent is that premise accepted by people in AI now and to what extent has the field moved away from it?

MOSES: Well, it's complicated. To some degree, I think, the notion that you have to know something is certainly accepted. A lot of AI, nowadays, is what you might call Modern AI, which is, to people who are interested in certain parts of the problem, computer vision, robotics, learning theory, speech understanding. These can be combined, but they usually are not. People create rather deep specialties in each one of those areas and the goal is, largely, to do very well and be helpful. The goal of trying to understand how the mind works is lost a little bit and we're now trying to get back to it, I think, for example, using some ideas from cognitive science. My own particular pet idea, which is not necessarily widely followed, is to, essentially, try to understand what you might call the organization of the brain. How does the brain do it? And then, try to see to what extent we can use that to utilize computers to better solve problems.

INTERVIEWER: Are you still working in this field now?

MOSES: Very little. It's not one of my major areas, at this point, but I might get back into it.

INTERVIEWER: When you first moved to Boston, even before you started class, you worked for a summer at Lincoln Labs.

MOSES: Yes.

INTERVIEWER: How did that happen? And, what was that experience like?

MOSES: Well, I knew at that point, say in May or June, I knew that I was coming to MIT and I was looking for a summer job. And, lo and behold, I found out somebody was interviewing that day from Lincoln Lab. Oh, gee, I think I know something about Lincoln Lab. So, I got on the schedule. I was the absolute last person he saw. And, he asked me, "What would you do? " And, I said, "Well, I know something about the computers you use. Something about the problems you're interested in." He was pleased enough, he recommended me for the job. So, I went that summer to work at Lincoln. The supervisor said, "Well, we're now developing a special machine with word length of 4,096 bits," where as most word lengths were 36 bits or 32 bits or whatever. This was huge! What could we do with it in order to do language? Gee! And then, he left for the whole summer! And, I was I left to myself to try to figure out what to make of it. And, I, basically, came up with an analysis of how to use 4,096 bits in searching records. Information retrieval it would be called today. For words as well as numbers. And, when he came back, he wasn't thrilled. What can I say? He wasn't there all summer.

INTERVIEWER: This was during the Vietnam War. It was a time when a lot of critics were protesting against MIT's relationship with Lincoln and the instrumentation lab because so much of their work was for the defense department. Did this concern you at all? Were you aware of it? Did you think about it?

MOSES: You're jumping a little bit ahead. The major issues related to Vietnam occurred, I think, '68 to '70. And so, it's five years after I entered MIT. Fall of '63 or, if you will, June of '63.

INTERVIEWER: But the summer you worked there, did it cross your mind?

MOSES: At Lincoln, no. At Lincoln, it did not. Of course, you couldn't help it when you went on campus, as time went on, because it became such a major national issue as well as a campus issue. I was somewhat involved in it eventually, largely because of the young lady who became my wife. She was in Northeastern and she was chosen to represent all the Northeastern students in discussions about what to do about the war, et cetera. Some of those discussions took place here at MIT. She led me into that situation to some degree. We went to Washington a number of times.

INTERVIEWER: If you want to come forward now to the 1980s. I think you were beginning to refer to when you chaired a committee to reexamine MIT's relationship to Lincoln Lab and whether it should be changed. How did that go and what did you conclude? And did your experience during that 1970s summer affect how you approached or how you thought about it during the committee work?

MOSES: Well, indeed. One of the department heads -- the one who hired me into the EE department, Louis Smullin -- and Louis, in the late '80s, he may have been retired at that point. I think he was. But, nonetheless, he made a point to question whether MIT ought to continue its relationship with Lincoln Lab. MIT supervised, if you will -- well, not supervised; that's the wrong word -- effectively managed, but it didn't, in any detail, the operation of Lincoln Lab. And, following the situations in the early '70s that we alluded to earlier, Lincoln Lab, basically, could not go beyond a certain point in developing technology. They couldn't make war- fighting equipment, as Draper did. And, that's why Draper needed to be separated from the Institute and Lincoln. What had to be done is that the president had to promise, guarantee, if you will, to the trustees, that Lincoln was not building equipment beyond a certain point. In any case, Louis made a request that we reexamine this. John Deutch was the provost at the time and he asked me to chair a committee to look into the relationship. I not only went and interviewed people at Lincoln, but I also took a tour around the country. I went to see what things were like at Livermore, Los Alamos, at Johns Hopkins' Applied Physics Lab, at Caltech and decided that, you know the committee decided basically, that not to make a major change in the relationship but to make sure that there were more faculty involved in understanding what was going on at Lincoln and that there was more joint research between faculty at MIT and the campus and the staff at Lincoln. And, all of those things came to be.

INTERVIEWER: Let's go back to when you were hired as an assistant professor. When you were approached in the hallway, or whatever, was that, essentially, an invitation to become an assistant professor as well as a researcher?

MOSES: Yes, it was an invitation to become an assistant professor.

INTERVIEWER: Had the department voted on it or anything?

MOSES: I have no idea. I have no idea. Things were "loosey- goosey" in those days. Searches were not national, necessarily. I don't know to what extent advertising was used. Basically, men -- largely men -- made decisions who was good. And, they would call their friends in other institutions, major ones like Berkeley, Stanford, and exchange information about who's available and things of that sort.

INTERVIEWER: But after getting your degree in Course 18, in math, you ended up as a professor in six.

MOSES: But that was natural.

INTERVIEWER: Was it?

MOSES: Yes, it was absolutely natural.

INTERVIEWER: They didn't ask you if you knew any electrical engineering.

MOSES: No, indeed not. But computer science was a growing field at the time. Where did the faculty come from? Well, Minsky came from math. Corbato came from physics. Many of them came from electrical engineering. And, the locus was in the EE department. And so, the transition, which Minsky already made from math to EE, was natural for someone interested in computer science and AI and computer science theory. Yes, all of those. And so, it wasn't a significant transition.

INTERVIEWER: Was that fairly typical in other universities, too?

MOSES: Every university seemed to be dealing with things in their own way. Probably, most complicated may have been Berkeley, where they had some computer science in the math department, computer science in the EE department, and then they combined faculty at some later point than we did. Let's see, in '67, there was just barely a computer science department at Stanford. Just recently, maybe, one at Carnegie Mellon. In the next 10 to 20 years, of course, there was a significant growth in the number of departments of computer science. Now, EECS was an unusual model.

INTERVIEWER: Although, it didn't become called that for a while, right?

MOSES: Yes, it didn't become called that for a while, but having so much computer science within an EE department was unusual and it led to interesting events later on.

INTERVIEWER: Which were?

MOSES: Well, in '73, Louis Smullin, the person who hired me, announced that he was going to retire. At that point, we had already hired quite a few computer scientists. Barbara LIskov, Albert Meyer, and Jerry Saltzer. These are the new generation. I was in that generation. There was a move afoot to split the department into an electrical engineering one and a computer science one. Now, mind you, in the '70s, the president, provost, the chancellor were all electrical engineers. Wiesner, Walter Rosenblith, Paul Gray. The power was, if you will, in the EE- side and I thought that it would be wise to stay as part of the EE department because of such a tremendous history, such great strength, and so powerful. I didn't buy the notion that by splitting, you'd gain power, which was the key argument. And so, I worked against it.

INTERVIEWER: And, the three of them were predisposed to keeping it together? Or did they have any -- Paul, and Jerry. I didn't realize Walter was in Course 6, also.

MOSES: Oh, yeah. I don't know. I didn't talk to them. Because, at the time this happened, I was untenured. And it so happened that I got elected chair of a committee that Louis created called the advisory committee in the EE department and I was elected chair. So, now the question is, how do we advise a department head about what we should do about this issue? And, basically, a number of us thought it would be wise not to split. And, I came up with a questionnaire which I sent to every faculty member. And, I said, "Well, some of us have thought about changing the name of the department and here are three options: electrical engineering and computer science, electrical and computer science and engineering, electrical engineering and science, -- well, electrical science and engineering and computer science and engineering. What do you prefer?" I don't remember the exact number but it was around 80 percent said electrical engineering and computer science. Only one person said, "Gee, can't we keep the old name?" That was Louis Smullin. Anyway, so I used that with the visiting committee -- you know, these all powerful visiting committees of trustees and others that MIT has and is one of the reasons it's so strong is because of this particular concept. And so, we presented the results to the visiting committee but at that point, we had a new administration in the department. Bill Davenport was chair. Corbato, Penfield were the associate chairs and they took that suggestion forward and more than a year or so, the name was changed. Electrical engineering and computer science. And, as a result, I think, the discussion about breaking it up had pretty much died.

INTERVIEWER: Because you were giving fuller recognition to the computer science part of it?

MOSES: Correct.

INTERVIEWER: And, did you know that when you put that survey out?

MOSES: Absolutely.

INTERVIEWER: Had you thought that through?

MOSES: Yeah, oh, absolutely.

INTERVIEWER: So this was a political move, in a sense?

MOSES: It was a tricky political move.

INTERVIEWER: Your first one?

MOSES: No.

INTERVIEWER: No?

MOSES: That was the one that some people remember.

INTERVIEWER: Is that, do you think, the beginning of your path toward administration?

MOSES: No, what happened there was the advisory committee was created in '71, maybe. Maybe '72 -- let's say '71. And elected its own chairman. It was Michael Dertouzos, who later became, for many, many years, head of our Laboratory for Computer Science. And, Michael called me one day. I was in Michigan giving a talk. And, he said, "I'd like you to chair a committee." And, the committee's job was to figure out what the impact would be on the department if it could no longer grow in size. See, what happened, apparently, -- well, I looked at data, so it's not so apparent -- yes, what happened was, beginning in the mid- '50s, the size of the faculty at MIT grew. And, it grew in the EE department, especially. So that, by '68, we had 125 faculty. Unbelievable. Wow.

INTERVIEWER: In Course 6?

MOSES: In Course 6. And, that was not sustainable, given the budgetary situation.

INTERVIEWER: The kind of growth or that size?

MOSES: The size and beyond that, the growth. Certainly not the growth, but even that size could not be sustained. And so, the question is, given budgetary restrictions, what was likely to be the outcome? And, I came up with a fairly simple model that -- one variable model -- that said if the probability of making tenure of the people we currently have is similar to what it has been in the past, we have now, currently, 45 percent tenured. Within a decade, we'll be 80 percent tenured. If the numbers don't grow -- total numbers -- our ability to hire will be much reduced. May be able to hire two, three faculty a year as opposed to six or seven. It was so simple and straightforward, people looked at it and said, "That's got to be right." Of course, it was right. It came to be and the dean of engineering, I think, sent it around, the Institute and people knew who I was all of the sudden. It was fun. Another fun thing to do. So, I became a creature, in some ways, of that committee -- the advisory committee -- to Louis Smullin. We not only made suggestions about the name of the department -- of whether it should split or not. We made suggestions about what the required core courses in the EECS should be.

INTERVIEWER: So this is the very same committee that Mike Dertouzos had --

MOSES: Yes, he chaired it for a year, or so, and then, he suggested -- of course, he couldn't impose it as well -- he suggested that I replace him. And, I became the chairman the next year.

INTERVIEWER: And you were already on the committee.

MOSES: I was on the committee.

INTERVIEWER: As an untenured --

MOSES: Oh, absolutely. As an associate without tenure.

INTERVIEWER: And, did it ever cross your mind that perhaps being on the committee, or the outcomes, or what you said would affect whether or not you got tenure?

MOSES: No. Basically, again, I didn't care. Gee, I'm having a good time and these are important issues and let's do something about it. And if I get tenure, fine. And, if I don't get tenure, oh well. Remember those calls I used to get? Well, they'll call again. I just wasn't planning for myself. And, I just did what seemed like a natural thing to do. Things were going well on the research side, in my opinion. I was never an outstanding teacher -- I was okay, I suppose. So, things were going okay in that regard. I was spending more and more time on this thing and, hey, it's doing good for the Institute. I loved it.

INTERVIEWER: And, the research you were doing at that time was?

MOSES: Was an outgrowth of my PhD thesis and Bill Martin's work. At that point, Bill Martin had already separated himself from the projects. I was running the project. We built a system called *Macsyma.* It's a name that I invented because it means different things in different languages. Latin and it even has a Hebrew meaning. It's related to the word, *kismet. Maxeema* -- magical, wondrous. And so, when I realized the multiple meanings, I thought, oh, that's a good name. And, we were building this system and at that point, we were probably getting a lot of users on the ARPANET, which was a precursor to the Internet. The ARPANET published the leading sites and for a while we were the number two site in the country because people were logging in on our computer.

INTERVIEWER: The number one site being?

MOSES: I don't remember.

INTERVIEWER: Another university one?

MOSES: I don't know. It may have been something like BBN or, I don't remember what the number one site was. And, of course, we weren't number two forever. Just for a few -- some months -- or, maybe, a year or so. Again, people were having a good time using our system. Finding errors, yes, every once in a while. They were publishing papers. They were publishing papers.

INTERVIEWER: What did it mean when they used the site?

MOSES: Well, they had problems, let's say, in engineering or in physics -- often in physics -- which, you'd have to use formulas. They had to differentiate or, in some cases, integrate, simplify, do power series expansions of one kind or another. All kinds of people using it. And they were talking to us by e-mail. It was fun.

INTERVIEWER: Did they tend to use it because it would have been difficult to get the answers, otherwise, or it was just faster?

MOSES: It was faster. And, in most cases, more accurate. Now, every once in a while, a bug would come in, so I can't guarantee the accuracy. But, yes, the accuracy was an issue as well as the speed. Sometimes they would calculate -- this would have taken me six months of handwork, et cetera, and now I can do it in an hour or whatever. And now, it's become a standard situation. In the field, you have systems that millions of people use. The outgrowth of what we did in *Macsyma.* Systems like mathematica --

INTERVIEWER: Now, a calculator -- a sophisticated calculator -- can do some of that or no?

MOSES: Yes, yes. For a long time, TI's calculators were able to do some of that. But, again, the large systems -- again, are outgrowth of work we did in the late '60s and '70s.

INTERVIEWER: And, besides the committee work and then, this research what was it like to be a young professor at MIT at that time?

MOSES: Oh. Good question. Teaching, of course, was another issue.

INTERVIEWER: How much did you teach?

MOSES: I taught a subject a term.

INTERVIEWER: Only one.

MOSES: Like everybody else. Yeah.

INTERVIEWER: Undergrad?

MOSES: In the School of Engineering, the tendency was one subject a term. Later on, I found out that it wasn't true everywhere. So, for example, in mathematics, they teach three subjects a year. One in one term, two in another. In humanities, they teach four subjects a year. I didn't know that at the time. I thought everybody taught just one subject. An undergraduate subject one term and a graduate subject another term. That's what I was teaching. And, the undergraduate subjects were a lot of fun. Especially, if you could get freshmen in the first term because they hadn't yet been inculcated into the MIT system and they were still quite excited about what they're learning.

INTERVIEWER: And they weren't later on?

MOSES: By second semester, they were already into the issue of, "Let's see. What's the minimum I need to do to get an A or to do well in this course?" Less so in the first term. Especially before Thanksgiving. Something happened around Thanksgiving. But, the key is that the older students had a lot of influence on the attitudes of the freshmen. Yeah, that's how it was. It still is.

INTERVIEWER: Did the existence of pass-fail affect attitudes at all, that you were aware of?

MOSES: I was there in the transition. Pass-fail came to be, I think, around 1968. I started in '67. My first semester of freshman was well before pass-fail.

INTERVIEWER: It may have been 1970, or so. I'm not sure, exactly.

MOSES: '68 is when, I think, Walter asked Amar Bose to chair a committee looking into either pass-fail or IAP, I forget which. But, those two issues came out in the late '60s so, I don't know enough about the change that occurred because I only taught for one year -- or maybe two -- before pass-fail came to be.

INTERVIEWER: What courses have you liked teaching the most? Are there any that are just more fun?

MOSES: Certainly, in the early years, the undergraduate programming course was fun. In fact, it's interesting; in '78 I was supposed to teach a new approach to the introductory course. And, Hal Abelson and I were going to develop this course. And then, it turns out, I became associate department head and I wasn't teaching. And, Abelson then changed to Gerry Sussman and they developed this remarkable course, 6.001, which they taught it for 25 years, or whatever. It was one of the most popular courses at MIT.

INTERVIEWER: And 6.001 is?

MOSES: Is, essentially, an introduction to programming using a LISP- like language. LISP, being the fundamental language used in AI and Sussman, in the mid '70s, figured out how to fix a technical problem with LISP and created a language called Scheme. That's another story, in itself. How did it get to be called Scheme? In any case, it was extremely popular and much better than anything I could have been involved in. I'm glad that I got out in time.

INTERVIEWER: So, it was actually about 14 years before you were pulled into administration. It sounds like you were doing a lot of committee work.

MOSES: Actually, no, it was 11 years.

INTERVIEWER: I guess before you became department head.

MOSES: Yes, I was associate department head. Associate department head, in that context, was, basically, a full time position. At least, I made it pretty much a full- time position. I was in charge of all the computer science faculty. 30 to 40, I forget the exact number at that time. And, that's a sizeable department in itself. So, Dick Adler was the associate on the EE- side and Gerry Wilson was the department head, and he was pretty much -- pretty amazing -- what he got done in those three years before he became dean of engineering.

INTERVIEWER: And, what did he get done in those three years?

MOSES: Well, he started a lot of things, some of which I was able to finish. What a key issue was the department's move into VLSI -- Very Large Scale Integration. Because, it's EE and CS department, the EE- side could deal with the, if you will, hardware part of chip making, and the CS- side could deal with the design part of chip making. And, they could combine forces readily. Tremendous argument for maintaining an EE and CS department. We were looking for such arguments. The other thing is we got Jerry Wiesner to get some money for us to buy some computers. We really didn't have educational computers worth beans! And he did it. It's great.

INTERVIEWER: He didn't tell you to go build them.

MOSES: He didn't tell us to go build them. He made some calls and he got, I don't know, a million or so. Which, obviously, was worth a lot more in those days.

INTERVIEWER: These were from where? Digital Equipment?

MOSES: Yeah. Largely DEC. Yeah, largely DEC. And, we got a big machine from DEC. And, we got a computer center to put it into with air conditioning equipment and all that. All of that happened. That was a minor thing. And then, he started a number of things. The department was going to have its 100th anniversary of electrical engineering. Not the department. The Institute was going to have the 100th anniversary of electrical engineering education. It started in the physics department in 1882 and in 1982 would be 100 years. And, in preparing for that, we did a history of the department and we hired a writer to work with one of our older faculty members. That book came to be. Gee, I'm forgetting one or two major things that he did. Oh, yeah, the EG&G building.

The department used to meet in what is called, the Bush Room on the main corridor. Well, the Alumni Association moved in there and they kicked us out! Well, there wasn't any room where we could meet regularly. So, he told Doc Edgerton and Jerry Wilson. He told Doc Edgerton, "You know, Doc, what are we going to do about this? We can't meet!" And Doc says, "All right! I'll give you half a million dollars. Go ahead. Build it now." Gerry said, "Wow! I got half a million dollars. Now, let's see what we can do with this. We have other needs." So, he and Paul started working on trying to figure out what the total needs of the department --

INTERVIEWER: He and Paul?

MOSES: Gray, yeah. Paul Gray had become president around 1981. They came up with a building that would cost [LONG PAUSE] $4 million. Not half a million. $4.5 million. It would have five floors. No, four floors. Four floors. The top floor would be the meeting room, a floor of classrooms, and then, a big lecture room. Paul went to try to raise the money. First, he got Doc Edgerton to go, "All right, all right. I'll give you $1.5 million." Then, he went to Edgerton's partner, Germeshausen, and Germeshausen said, "All right, I'll match Doc." So, now you have $3 million. Finally, he went to Grier. And Grier, in his lifetime, apparently had only given around $50k to MIT, so he was hoping he'll get something. Something. Maybe more, but not much more. Grier said, "All right, I'll match him." So, now, he had $4.5 million. No, I was wrong. The cost eventually wound up being $5 million, because Gerry decided he needed to have a top floor of laboratories for 6.001, among other things. And, so, Doc gave him another half million and we got some from the company that they founded, EG&G.

INTERVIEWER: So, this was building--

MOSES: Building 34.

INTERVIEWER: 34.

MOSES: It was supposed to be there between 36 and 38. When Jerry was trying to get the money for it in the early '70s for that complex, he was having a hard time getting a teaching building between 36 and 38. 36, being the Research Lab of Electronics. Thirty-eight, being the department headquarters, largely. So, he put in just corridors combining the two. And, EG&G filled in the corridors, eventually.

INTERVIEWER: As associate department head, you were responsible for the computer science half, or portion, of the department.

MOSES: Right.

INTERVIEWER: What was happening to the field and what were you trying to do with the department? With that portion of it during those years?

MOSES: Well, it wasn't clear to me that we had a clear idea. What we wanted to do was hire the best. And, unfortunately, the number of openings was very small. Like, maybe one a year. So, I was in charge of the search and it was difficult to make a decision. But, we did try to hire the best we could.

INTERVIEWER: And you were getting more and more students during this period?

MOSES: No, not yet. Yes, we were. This issue will come up when we talk about when I was department head. What was happening is between '72, which was a low point, not only in computer science, but also in engineering. I don't know if you remember the Route 128 area was in a major recession in the early '70s because we had gone to the moon. And, we were cutting down, to some degree, in Vietnam and the army situation. The Department of Defense, which funded a lot of the work on campus in the '50s and '60s was thinking that it couldn't do so anymore because of the so-called Mansfield Amendment. The Mansfield Amendment was created by Mike Mansfield against the objection of Jerry Wiesner, by the way. And it, basically, said the Department of Defense can only do research on things directly related to military needs. And, they used to fund a lot of research but it couldn't be said to be directly related to the military. So, there was a lot of reduction there. '72 was a low point. It was a low point in the number of sophomores in electrical engineering and computer science. We had two programs at that point. And, it kept growing and growing and growing. And so, by 1984, I was guessing, based on my analysis of the numbers, that we would be having 38 percent of all undergraduates major in EECS. And, I declared the crisis. I said, "We can't do it. " And, with the current faculty, we can't, then, still maintain quality and et cetera. It became a major issue for the faculty and MIT, as a whole. And, Paul Gray was wonderful in dealing with it. He actually taught while he was president. He taught a section of our introductory circuits course. He got the perfect score. Why? Partly because everybody knew he was the president and partly because he never used notes. The kids were absolutely thrilled by having someone who really knew the material cold. Never having to use notes.

INTERVIEWER: And so how did he and you solve this? Or how did it resolve itself?

MOSES: There was a motion on the faculty floor. There were several motions, but, basically, the idea was-- our view was either the numbers sort of naturally went down, or MIT should require high school students who apply to indicate what they were going to major in and use that to decide how many electrical engineers, computer scientists they would accept. Now, we didn't like that idea. The committee that looked at it from MIT's wide perspective, basically said, "No, no, no. That shouldn't be the way. What should be done is in the springtime of their freshman year, when students have to choose majors, have them declare what they were going to do and have them take an examination. And, you guys choose the ones you want to keep." Whoa! It puts the onus on us. Well, we didn't like that. In any case, it came to a complicated series of votes on the faculty floor with Paul in charge as president. And, everything failed. Those motions, at least. And so, what we were left with was a notion that the number of students had better ratchet down over the next three years, otherwise, we'll have to revisit the issue. Surprise, surprise! They ratcheted down.

What happened in 1985-- I think it was '85, could have been '84, but I think it was '85-- the expectations of the computer industry was that the number of microprocessors or chips or whatever would double from one year to the next. Well, it didn't double. It only went up 25 percent or some such thing. Well, a crisis! Okay. And so, the students-- especially, women students, I believe-- who may have felt that this was a good way to avoid the cyclical behavior of most engineering fields-- because computers had never gone down. Okay, now they're going down. We don't want to major in that. It's just as cyclic as, or near the others. We really lost a lot of very good women who started majoring in computer science in the '80s. I don't know-- I haven't kept up the numbers-- we may have recovered, but, my guess is that it made a tremendous long term difference.

INTERVIEWER: Were you surprised when you were tapped to be department chair?

MOSES: No.

INTERVIEWER: Did it seem obvious?

MOSES: No. At that point. with Gerry Wilson becoming dean. there were really only two options. I thought I would be it. I'm pretty sure my EE colleagues, some of them, were a little nervous because I didn't know much about electrical engineering. But, within a year or so, I think, it was pretty clear that it would work out very well.

INTERVIEWER: So, what other challenges did you face as chair of the department besides the question of enrollment and getting to know the hardware side?

MOSES: First off, we had to finish the agenda that Gerry Wilson started. We had to get a major integrated circuits lab in Building 39. Paul was tremendously helpful-- Paul Gray-- tremendously helpful in kicking out the computer center and in dealing with our part to get us some financial relief. Dick Adler did an outstanding job as the associate head on the EE side working with Paul Penfield, who later became department head. And, to build up a lab, and get the contracts for both the design and for the IC's work, building up connections to the industry that gave us money as well as equipment, that was a major undertaking. Again, largely, done by Dick Adler, Paul Penfield. Of course, we had to have the celebration of the 100th anniversary of EE education and the book. A lot of things were done. EG&G building was finished. I remember one time, people were telling me, "Hey, you gotta watch Doc! He's putting in Coke bottles in the ground!" EG&G building was right outside my office, so I ran all the way down and there was Doc on the ground, sticking in these Coke bottles. I said, "Doc, what are you doing?" He said, "Well, when I go exploring in the Aegean, I see these amphoras, and whenever I see an amphora, I know there was Greek civilization. A thousand years from now, when they find this Coke bottle, they'll know there was an American civilization." He was wonderful.

INTERVIEWER: What was he putting in those bottles?

MOSES: Nothing. He was just putting the bottles in! What does he have in the amphora, by now, when you find them? Nothing!

INTERVIEWER: I didn't know if they had oil in them, or--

MOSES: So, those were things that happened in the first few years of that administration. And now, I created a number of events, if you will-- when I stepped down in '89, someone came to me and they stopped me in the corridor, and they said, "You know, I'm going to remember you for something." I said, "what?" He said, "A four letter word. Food!" What happened is I created-- once we had the EG&G building, we had regular meetings of the faculty around lunch. I created a dinner for faculty and spouses just before registration day in the second term-- the spring term. That was a great event.

INTERVIEWER: This is within your department?

MOSES: Within the department, yeah. So, we would have 100, or so, people. At the January event, usually. People would come to these lunches and find out what's going on in the department.

There was one time people tend not to forget when I talked about a new hire we made. We tried to get this guy when he was graduating from Stanford in integrated circuits. He said, "I'm going to go to Japan. I'm going to learn how they do things." Now, he was ready to leave Japan, so we made him an offer. And, I told the faculty that I wrote him a letter. And, his name is-- well, you'll see. Jesus del Alamo is his name. So, I said, "Dear Jesus. Please come back to the Promised Land." Signed, Moses. And, people laughed so hard! I didn't have the heart to tell them that I didn't actually sign the letter. And so, those were some of things I did for the department.

Then, I broadened a little bit and I did some things for the Institute.

INTERVIEWER: Even while you were still department head?

MOSES: Yeah, we're now talking about right after the relief on the enrollment side, I, basically, had the notion that what we ought to do is the build collegiality at MIT. The way to do that might be to have groups of faculty meet on a regular basis and talk about whatever-- technical issues. These would be from throughout the Institute. And so, I went with this idea to the main Institute committee at the time called the Committee on Educational Policy. I said, "Well, we should have 20 groups of randomly chosen faculty-- about 50 people. There were about a thousand faculty and each would meet, maybe, once a month at the faculty club and, that way, almost every working day of the month would be used up and they could talk about whatever. And, this would build up collegiality, et cetera. And, people thought that was crazy. But, there was one guy that didn't. He was the associate provost at the time. His name is Jay Keyser. And, Jay said, "Oh, Okay. I'll try it. I'll do one." And, there was another faculty member there, Allan Toomre, and, he said, "I'll generate the random numbers!" Well, it's still going on. It's variously called the Random Faculty Dinners or the Keyser Dinners. And Toomre still generates the random numbers so that he can choose people to attend them. And, it's been a tremendous success.

INTERVIEWER: Do you go to most of them? Or, any of them?

MOSES: No, no. He invites me, maybe, once a year-- once every other year. Then he shames me by pointing out to my role in all of this. He has made it work. Not me. It was all Jay. He's wonderful at doing that.

And, then at the same time, I created a couple of other things. One is now called by Jay the Moses Seminar. And, that's been going on for 25 years.

INTERVIEWER: Did you start when you were chair of the department?

MOSES: Absolutely. Yeah, at the same time.

INTERVIEWER: And what was the thinking behind that?

MOSES: The thinking is that we should have a group of relatively chosen group of faculty but not changing all that much, from every school at MIT, at least, initially. And, we would talk about technical issues that we were interested in. And, other people were interested in and willing to discuss with us. We've been doing that for 25 years. It's been quite successful.

INTERVIEWER: And is there really interest across all five schools in the same technical issues?

MOSES: No, there isn't. And, for different talks, we get different people coming. But, by now, we know who the core group is that would, essentially, come for a wide variety of talks. And, besides that, if Jonathan Gruber were to talk about health care policy, everybody would be interested.

INTERVIEWER: Was he one of your recent speakers?

MOSES: A year, or so, ago.

INTERVIEWER: You would have Minsky on artificial intelligence?

MOSES: Minsky on AI. Chomsky on linguistics. That was probably the best attended one we had. Weinberg on cancer. It just goes on and on. It's been a tremendously exciting undertaking.

INTERVIEWER: So, do you get lots of people saying, "I want to come to your group."?

MOSES: We don't advertise the group that much so that we avoid that issue. But, what happens is that if you give a talk, then you get invited from that point on. In addition to that, there was another thing that happened in '85. A professor in literature, Cynthia Wolff, came to see me and, she said, "The power at MIT is in the School of Engineering." All right. Some power. "The humanities faculty feel like they're not part of the core of the institution. Wouldn't it be nice if we could create a way of gathering faculty, especially from the humanities and engineering and science?" So, I said all right. We'll do that. It's called the symposium. And, it's still going.

INTERVIEWER: And, it's called what?

MOSES: symposium. Remember? Plato's Symposium.

INTERVIEWER: How often?

MOSES: Well, I don't know. That one works differently. You stay in it for a number of years and then you get off. I've been off a long time. But, my guess is maybe once a month.

INTERVIEWER: Oh, that often?

MOSES: Yeah. A member of the symposium would get up, talk about their specialty, and other people would comment. That one is a dinner event. The others are lunches.

INTERVIEWER: By the end of your term as department chair, were there pressures to cut faculty in your department or hold it down at that point?

MOSES: Yeah, that's a good question. Budgetary pressure at MIT is nothing new. It probably goes back to '68, when the Mansfield Amendment came into being under Howard Johnson. And so, it's been an issue that's sort of simmering. Sometimes it's not so bad but sometimes it gets tough. And, in the late '80s-- the mid '80s, I think-- the idea was we needed to reduce MIT's costs. Some way. Gerry Wilson, certainly, was playing an important role, there, partly because of his interest in manufacturing and how manufacturing in the United States had to change given the pressure from Japan. And so, he, basically, said, "MIT needs to reduce the size of its faculty. To a first degree, the cost of the institution is a function of it size." I said, yeah, that's fine. Are the other schools going to go along? He said, "Sure, we're going to make them go along." It turns out, nobody else went along. But, Gerry Wilson reduced the size of, not the effective faculty, but the ones on board plus ones that you could hire et cetera. He reduced the number of potential hires. I said, "If you don't go along with the other deans, the School of Engineering is not going to do well." And, I really opposed that unilateral move on his part. And, eventually, he wanted to clamp down on the size of the EE department. He didn't do that. He didn't do that initially because of the enrollment issue we discussed, but, when he did, I resigned.

INTERVIEWER: You thought it would be less fun?

MOSES: Yeah, that and I thought it was an unreasonable principle.

INTERVIEWER: So, what did you do after your resignation?

MOSES: I waited for them to find a new department head, and that wasn't as easy as they initially thought. But, eventually, they came up with Paul Penfield. And, I took a year off and spent the year at the Harvard Business School.

INTERVIEWER: Why the Harvard Business School?

MOSES: Partly, I couldn't easily leave. My kids were going to school in the area. I didn't want to go anywhere without them. I really got interested in the issue of manufacturing. Why we were not doing well relative to the Japanese, at least in the '80s. I was interested in organizational issues, again, the issue of my German background, if you will. I knew of some people at the Harvard Business School, what they've done. And so, I asked them, "Would you take me on?" They said, "Fine."

INTERVIEWER: Did any of the Harvard Business School rub off on you? Did it influence your own management style? Or change your thinking in any way when you came back? A very different setting.

MOSES: Well, I was impressed-- I hadn't expected to be-- by their teaching. One of the people there whose work I liked George Lodge. George Lodge ran against Kennedy in 1962. He lost. And so, he became a Harvard Business School professor. He did sociological comparison of Japanese and Germans and other countries with the US, et cetera. And, I liked that. And, I asked George. I said, "What would it take for you to miss class?" He said, "Never done that. 104 degree temperature and I'd considered it." I was impressed. These guys travel all over writing their cases, et cetera. They get money from the school to do this traveling, but they make sure to schedule it in such a way that they don't miss classes. And, MIT, if you have to go to a conference, you get somebody to take over for your class. That's the reasonable thing. These guys don't. And, the case study teaching really is not easy. It requires a lot of careful attention to details and what the student is saying relative to what you think is going on. I was impressed with the teaching. That, I had not expected.

In terms of the research, I actually taught a course there. I was less impressed by them. Very good people, but not as mathematical, maybe. Not quite like my style.

INTERVIEWER: When you stepped down as chair, did you think about whether that was the end of your administrative career?

MOSES: Yeah, yeah. I figured as much, yeah. But then, Gerry stepped down about a year later. Gerry Wilson. And, they were looking for somebody and I interviewed. I told my wife, "Nah. It's never going to happen."

INTERVIEWER: Why'd you think that?

MOSES: I don't know. Members of the committee were asking sort of what seemed to be nasty or difficult questions.

INTERVIEWER: Like what?

MOSES: It's a long time. I didn't think it would happen. It did happen. Fine. Okay. Jerry stepped down on January 16 of 1991. I met with Mark Wrighton, who was provost at the time. Actually, I was a candidate for provost. I'll be honest about that. I forgot-- during the year, they involved me a little bit in the search for the president. But, Mark Wrighton became provost did very fine work. But, he interviewed me, I think, after the 16th. And, he back dated the appointment a few days. Okay. There was no time lost, if you will.

INTERVIEWER: Did you and he know each other very much?

MOSES: Not much.

INTERVIEWER: He was from chemistry?

MOSES: Chemistry, yes. I think people knew of me as department head because of the crisis on the enrollment that we discussed. I think that's what, mostly, what people knew about me at the time. Maybe they knew other things.

INTERVIEWER: So, what were the challenges on the table or the problems for dean?

MOSES: Well, before I answer that question, I'll put it this way. The structure of MIT is department heads, not chairmen. Department heads have a lot of power. The provost and president have a lot of power. The provost usually runs the budget for the Institute. Department heads have a lot of authority. They have to do hiring, et cetera, et cetera. The deans, ah, not so clear. At least, then. The dean of the Sloan School, who was, really, a department head of a very large department. That's one thing. But, the dean of engineering, dean of science, and other deans, had less power than, let's say, they do at Harvard, where they're all powerful deans. They control the endowment for that school and all that jazz. The dean here could do things which he or she found interesting. And, Gerry Wilson did Project Athena, which, actually, I had a major role in. He led us in manufacturing, which I had a very minor role in. I thought, one of the things we should do is do something parallel to the Leaders for Manufacturing in the area of design. And, that became the System Design and Management Program. So, as dean, you can do interesting, useful things partly because the standard issues of dealing with the faculty are not as big as a dean as they are for department head or the financial issues are not as big as they are for a provost. So, I had fun. I had enormous fun as dean.

INTERVIEWER: Did you?

MOSES: Absolutely.

INTERVIEWER: One issue, I think you had to face was questions about some of the smaller engineering departments in the school, which were coming up, then, because of financial issues?

MOSES: Again, we were all constantly looking for ways to reduce costs and, if you ask yourself, which department in the School of Engineering-- were not as easily justified. Well, there were two of them. Pretty obvious. Everybody knew which they were. Nuclear engineering. Ocean engineering. And so I, in concert with the provost, president, agreed to try to see what I could do about nuclear engineering. The issue there, then, was that there hadn't been a new plant on order in a couple decades. It wasn't clear if things were going to change. What's the future going to be for that department? The department said they were going to go into bio area. Nuclear plus bio. That's fine.

INTERVIEWER: Because they had the radiology. They had fission and fusion and radiology?

MOSES: That was their three areas. Fission, fusion, and radiology. Fusion is always going to be the technology of the future. It's not clear how many faculty you need, because, in many ways, physics, also electrical engineering, were heavily involved in that. Fission was the fundamental problem. So, I thought, maybe what we could do is combine the department with mechanical engineering as had been done in many other universities. And so, we had a meeting over dinner. And, I suggested this. Of course, they were opposed.

INTERVIEWER: You had a meeting with whom?

MOSES: The faculty in nuclear engineering. So, I came back and I talked to the department head extensively about the idea of reducing the faculty size over time. We also talked to the visiting committee. Again, these are extremely important committees for the Institute. visiting committees. We talked to them about the issue. So, people knew that was on the table. And, the department was willing to undergo a reduction in size over a period of a decade, or so. And, having gotten that through, the ocean engineers came forward and said, "Okay. We'll take a similar deal. A reduction in the size of ocean engineering over a period of a decade or so." And, both things came to be.

INTERVIEWER: And, the plan was to reduce out of existence? Or just to bring down costs--

MOSES: Bring down costs by reducing the size of the faculty from, let's say, 20 each to-- I don't remember the exact number. Let's say 10, 12 to 14.

INTERVIEWER: Would those have been efficient administrative units once they got that small?

MOSES: No, that's a good question. Nuclear engineering managed to stay and is a viable institution and it's now, presumably, grown somewhat, as nuclear option has come to the floor again, which I'm pleased with. Ocean engineering, which is a unusual department because it's not clear in terms of foundation They have foundational issues from mechanical engineering. They have foundational issues from electrical engineering. The get it from all over. It's a rather different sort of department. In any case, they eventually agreed to be combined with mechanical engineering. And so, one of the associate heads in mechanical engineering is an ocean engineer at this point in time.

INTERVIEWER: Did you also look at issues of how engineering students-- undergraduate-- should be educated and the balance of what they were taking? At some point, you were involved with that.

MOSES: Yes, I was. What Gerry Wilson started was the notion of a long- range plan of five years. Five- year- plan. The first one, maybe '82 or '83, led to Project Athena. The second one led to a notion called Large- Scale Systems, which you'll probably get to in a minute. I started one when I became dean. Maybe in '92, ended '93. I wrote a report called, "Engineering with a big E." Where did I get that idea? Well, Leaders for Manufacturing viewed itself as Manufacturing with a big M, meaning it goes across manufacturing into design and other aspects of the firm. A manufacturing firm. And, I wanted to indicate "Engineering with a big E" is broader than just engineering. It involves the social sciences. It involves management and things of that sort. How did that come to be? When you think about the major change in engineering education in the 20th century, one of them was the effect of World War II, which led to the Engineering Science Movement. Gordon Brown was head of the EE department in the '50s and he played an important role in creation of engineering science. The idea being that they learned in World War II, especially here at MIT at the Rad Lab, they learned that physicists, scientists generally, are better at fundamentals. More flexible, as a result in being able to deal with new kinds of problems than engineers who were taught from the books of the '30s, if you will. So, they wanted a more fundamental approach which emphasized more math, more science. But, something had to give. What gave, I suspect, was largely emphasis on design, emphasis on management, actually. Management of engineering firms was a subject taught a number of years in the EE department. Anything having to do with environment or manufacturing, et cetera, just wouldn't come up. So, by the '80s, when we knew that manufacturing was an issue, it seemed like having such a strong emphasis on math and science is good. But, at what cost? So, there were two ideas around. One is that we ought to see if we could require a fifth year for every student. At the end of five years, I'll get a Master's all right. But, we'll try to get them to take that extra year and then we can broaden them as well as deepen them somewhat. And, if we knew that the student's going to do five years, we could start some of this earlier on. So, "Engineer with a big E" was an attempt to broaden engineering education to deal with some of the issues that, in some sense, were allowed to slip by in the Engineering Science movement, which was extremely successful, no doubt. And, it made MIT's EE department. We wrote the books. The Red Book. Oh, no, not the red. The Green Book Series in the '50s was, essentially, an engineering science series and it put the EE department on the map more than ever. And so, now, this was a more risky kind of a move. Two parts: it's a fifth year and the other one is the broadening.

Paul Penfield, in particular, when he was head of EE department, tried to convince other heads, other chairmen-- chairwomen-- of the EE departments to I adopt this fifth-year approach and they wouldn't. But, we were able to do that, certainly, in the EECS department through what is called a master's of engineering degree. Which is in a fifth year, you do a project and you get a Master's as well as a Bachelor's degree. A key idea for that that came in one of these committee meetings in the mid- '80s when someone pointed out that the students who were in our Co-op Program, 6A, so-called, were relatively successful having done a Bachelor's and a Master's in five years. So, why don't we see if we can do a Co-op- thing on campus for the rest of the students? And, that's what the master's of engineering is, to some degree. You do your Master's work project on campus rather than at the company site.

INTERVIEWER: And, did this apply to all the engineering departments or was it mainly Course 6?

MOSES: It could. But, it turns out to have been most successful in Course 6. It was tried, I think, in aero. Wasn't that successful. It may have been said to have been tried in civil. Again, not that successful. And, mechanical absolutely refused to do it. So, yeah, it really works for us. Yes, it has side effects because the introductory graduate courses had to be changed a little bit to meet the different quality standards of the MIT EECS students and the entering doctoral students. But, yeah, on the whole, I think, people would say it's been a success. And, it's still not a national thing. And, furthermore, the broadening hasn't been quite as strong as it could. It's become more so over the years. Mind you, this program's been around, now, for 16, 17 years, or whatever. So, we've done some broadening but not as much as I had hoped. There's always another administration.

INTERVIEWER: Tell us about your time as provost.

MOSES: Things happen all the time.

INTERVIEWER: How did you--

MOSES: The big issue while Mark Wrighton was provost was what would be the effect of RA and TA? Now, let me explain a little bit of what happened. In the early '80s when John Deutch was dean of science, he worked out a deal where the tuition for research assistants and teaching-- I think, teaching assistants, as well. Yeah, RA, TA was essentially added on to the pool of employee benefits for all MIT staff including ones at Lincoln. That was one of the issues at the Lincoln Lab Committee that we discussed earlier was to figure out what the effect would be. What happened, in effect, was that Lincoln was paying for the tuition of 700 students that they never saw through this employee benefits addition of the tuition to the pool. And, we had a very high EB pool. EB rate. And, so did other universities. Stanford, Caltech, Columbia, and Johns Hopkins come to mind as the other institutions that did a similar thing. And then, the accountants working for HHS said, you know, we don't like this because some institutions can do it and, of course, they were never-- HHS dominant institutions. Always Office of Naval Research dominant institutions. Our HHS institutions can't do this.

INTERVIEWER: This is Health and Human Services in Washington D.C.

MOSES: They said, you know, our institutions can't do it. Now, we'd like to have a standard approach all universities should follow. We argued, counter-argued, and said, "Do you realize that the federal government, as a whole, does better under this scheme than it does under the standard HHS scheme?" "No, we don't care." And, the reason is why would a provost agree to do something when it costs them more? The answer is because they'd reduce the cost of a research assistantship to our faculty, significantly. Therefore, to make them happy, he was willing to pay some.

INTERVIEWER: So you lost that and then the Institute had to pick up the cost.

MOSES: The Institute had to pick up the cost because there's so many people who are directly paid by the provost, if you will, who are not RA's, TA's, or researchers. There was this proposal to eliminate this inequity, they might call it. Mark created a committee chaired by Bob Weinberg. It had the dean of science, the dean of engineering, dean of HASS, a number of others. And we tried to figure out what the impact would be on cost of research. We said, "Oh, my God. It's going to cost so much more for a research assistantship. We'd lose out completely. All the students would go to other institutions. And so, we had the provost kick in some money in order to keep the amount lower. In particular, pay a significant part of the tuition.

INTERVIEWER: And so when you became provost, financials were one of the big issues.

MOSES: Yeah, but before we get to that. The last few months of Mark's administration, he came up with an arrangement which he said would, essentially, work out so that the Institute would not be as affected by, and the bottom line is the Institute wouldn't be so heavily affected by the change-over which would occur three years hence. Well, when I became provost, I looked at that issue once again. And, my conclusion was that that wasn't going to work very well. That the base budget was going to be in the red for several tens of millions of dollars a year and maybe even growing as we went forward. And, that became a major issue for me when I was provost is how to deal with that.

INTERVIEWER: And, did you figure out a way? Was there any way?

MOSES: There was a way, which was the pay-out of the endowment had to be increased. Now, at the time, my estimate was that the endowment was paying out a little over 3 percent. Most people assume that endowments pay out 5 percent. And, the difference in 5 percent and 3 percent is so large to take care of a lot of issues. But, it took a while to convince the trustees to go along with that.

INTERVIEWER: And this was in a period of a growing endowment.

MOSES: The endowment was growing and the payout, in terms of dollars, was only increasing a little-- 5 percent-- but, the increase was 5 percent.

INTERVIEWER: It lagged.

MOSES: It lagged the growth in the endowment by a lot and, mind you, this was a process that had been going on for 20 some odd years. And so, the lag was significant. My hope was that we could go to a more reasonable payout rate and deal with some of these issues.

INTERVIEWER: And they ultimately did change?

MOSES: Yeah. Working with Bill Dixon, who was my counterpart, senior vice president in charge of Administrative Services. We wrote a proposal to the trustees that was bought in. Allowed us to deal with almost all the financial issues by increasing the payout in the endowment significantly.

INTERVIEWER: Are there one or two other major issues that you grappled with as provost?

MOSES: Well, as always, the provost deals with almost everything. Space was an issue. Always an issue. It's a significant issue, I think, MIT going forward. We, for many years, just didn't put enough money into maintenance. We have a deferred maintenance between half a billion and a billion dollars. It costs us in many ways. One is that a new faculty member comes in and she needs a lab. You make a slight change in anything, they say we gotta bring it up to code because we haven't been doing it. Well, all of a sudden, the cost of the lab grows enormously. Makes it difficult to hire experimentalists of any kind. That's an issue.

An interesting thing that happened was a campaign was announced or about to be announced.

INTERVIEWER: A fundraising campaign.

MOSES: A fundraising campaign. And, it was my job to figure out what to use it for. I looked at Deutch's analysis of the previous campaign. And, I said, "Gee, we have to be careful not to put too much into the categories of gifts that we want to see. We have to recognize people give us money for the things that they want to see." So, when I did the different categories-- chairs, scholarships-- I knew I had to do fellowships more than I expected to see, but we really needed to have fellowships.

INTERVIEWER: Graduate fellowships.

MOSES: Graduate fellowships.

INTERVIEWER: To cover the RA, TA tuition--

MOSES: A little bit of that. Fellowships are a good thing because it allows you to attract some of the very best students that you might lose otherwise, even if you could hire them as RA's without any difficulty. So, those were usual categories. Then, I said, "Listen, they're going to give us money for research which we don't control because they want certain research done." I put that up a little higher than it would have been otherwise. And, I think my estimates were done right. Very close to being right. We eventually settled on a figure of a billion and a half, and when we made that, as we hoped we would, they raised it to two billion and they made that.

And, a thing that was tricky and, maybe, I didn't handle as well as I should have, was the notion that over a long period time, we hadn't been building much. And there was pent up demand. Of course, every dean had their favorites. And, of course, for 25 years, I was pushing for a building on campus for computer science. One argument being is to get the EE and CS faculty closer to each other. And, the other one is that being across the railroad tracks, as we were in Technology Square for many, many years, we were developing a culture that was different from the rest of the institution and I didn't like that. Deutch actually helped in this regard by pointing out that Building 20 had to be replaced because it had all of this asbestos. I spent the money to get rid of the asbestos. Not an easy thing. And then, we built a building on top of that space. And, we had a big party for the building. When we came down from Building 20. Paul Penfield did a great job in that party. And, we built the Stata Center.

INTERVIEWER: Do you think that's changed the culture of engineering or Course 6 very much?

MOSES: I don't know about engineering. EE and CS are much closer, I think. We're also across the street from the brain and cog and we're working with them a little more closely than we would have otherwise. And, the students have an easier time getting to the faculty. And, of course, the Student Street is a wonderful thing in the Stata Center. I won't go into the negotiations over that architects. I'll tell you one story about Stata-- INTERVIEWER: This may be our final story. We have just two or three minutes.

MOSES: Oh, I'm sorry. I was on Ray's board for 20 some odd years.

INTERVIEWER: Ray Stata.

MOSES: Ray Stata's board, Analog Devices. He knew about this need for a building and he was also chairman of the visiting committee. Finally, he came and he said, "I don't want to hear anymore about this. Here's $10 million." Sounds like Doc. "Here's $10 million. Start building this, already." We said, wow! After all these years of talking about it we actually have $10 million. So, we actually priced out the building and it was a lot more than $10 million. Well over 100. At one point, we had a meeting with Chuck and Ray and others. Barbara Stowe, probably, was at the meeting, vice president for Development. I said, "Why don't we have a building which has two towers? That way, we can get three gifts. One for each tower, one for the overall thing." And, at that point, I think Ray had already agreed with Maria to give us $25 million. And then we got $20 million from Gates. $15 million more from Alex Dreyfoos.

INTERVIEWER: Alex Dreyfoos.

MOSES: He was the one who gave us the money for the other wing, or--

INTERVIEWER: So, the tri-part system worked well.

MOSES: It worked very well. And, of course, we were able to get some additional monies for special rooms, part of the first floor, things of that sort. So, it added up to, maybe a gift total of around $90 million. Plus all the money we saved in not paying rent on Technology Square. But, nevertheless, the building is larger than I anticipated. Partly, because it has huge garages underneath. But, it has this wonderful Student Street.

INTERVIEWER: And what are you most involved with now? As a closing note.

MOSES: Systems engineering is an attempt at -- the School of Engineering has about 50 faculty. A dozen of them from the Sloan School. All but one or two of the engineering departments are thinking about issues like complexity and energy. But, from a slightly different perspective than the Energy Initiative. And, we have a lot of research support in other countries. Portugal, Abu Dhabi, Colombia.

INTERVIEWER: This is systems design.

MOSES: Design is one issue. But, it is more operations, all kinds of stuff.

INTERVIEWER: Was this ESD?

MOSES: Engineering Systems Division.

INTERVIEWER: And the Center for Technology, Policy, and Industrial Development?

MOSES: Is a sort of research on the arm of ESD to a first order. CTPID has been around for longer. ESD's been around for a decade, or so. But, the other one's been around for 20 some odd years.

INTERVIEWER: Is there a particular problem that's engaging your mind at the moment?

MOSES: Three things that I'm particularly interested in: foundational issues in engineering systems: Complexity, flexibility, robustness. Those are foundational issues. Health care policy. Dealing with infrastructure, roads. Of course, the Internet. Electric power. Seeing what the relationship is between them and how to avoid getting into serious issues with adversaries or, just simply, loss of electric power due to rain or, who knows what? It's a fascinating set of subjects. Much broader than what most faculty here tend to do. Involves us with social sciences more than ever and business school faculty.

INTERVIEWER: So, if you were going to graduate school now, what would you study?

MOSES: Ah! Yeah, I'd study that. Of course, the alternative is biology. Everybody says biology. Okay, so let me not say biology. I think I'd study systems. It is the set of issues which the world faces more and more all the time.

INTERVIEWER: Thank you very much for chatting with us today. Good luck with solving those problems. We'll all be better off.

MOSES: I hope so.

INTERVIEWER: Thank You.