INTERVIEWER: Today is August 27th, 2007. Brian Keegan is interviewing professor Mildred Dresselhaus for the MIT150 Oral History Project. Thank you for taking the time today to meet with us.

DRESSELHAUS: My pleasure.

INTERVIEWER: Now this project aims to capture aspects and perspectives of members of the MIT community who participated throughout MIT's history and it's on the occasion of MIT's 150th that we want to start to look back as much as to look forward.

DRESSELHAUS: When is the 150th?

INTERVIEWER: The 150th will be in 2011. April of 2011.

DRESSELHAUS: And you're hoping to get some aspects, some progress with it? You probably won't do everything that you want to, but it's sort of like the 250th anniversary of Mozart. They were rushing to get it all done by 2006. I remember somebody talking to me about that.

INTERVIEWER: Sure. Now we're going to skip ahead a little bit, maybe. We'll come back to your biography later, but maybe you can tell me, after you left Cornell in your postdoc, you were offered a job to come to MIT. What had you heard about MIT before? Tell me about the Project Whirlwind that you had been offered initially before you left for Cavendish.

DRESSELHAUS: Oh yeah. Well, Project Whirlwind, at the time I was offered that job, or that was the RA in the math department, at that time it seemed like an exciting opportunity. But I didn't really know too much about it. I didn't really know the history of these various computer projects that they had. They had had a previous project at University of Pennsylvania that happened during the War years, and that had a big impact on computation during the War years and brought computers into some level of contributing to computations for trajectories for missiles and so forth. But not that much I guess, because it wasn't very widely used. At that time, I guess people had already some idea of what computers might do, but only a very small inkling about it. So I had a chance to be involved in one of the early projects. And it would have been a totally different career had I done that, but I didn't come because I wasn't interested in it. I was just interested in the other opportunity more. So it was a choice between two good things. I know in a lifetime, you seldom have two really good things coming up all at once, and you have to make a decision. So my decision turned out okay for me. I have no idea what the other decision would have been, you know. It's sort of a useless issue. But looking back now at the history of computer science, that would have been a very interesting thing to be involved with.

INTERVIEWER: Now while you were at the Cavendish or Radcliffe or the University of Chicago, what awareness did you have of MIT or the research that was going on there?

DRESSELHAUS: The War years research formed a body of information that we use as text books. The radiation series was a terrific series on electromagnetic theory and many other things. So it was a constant reference source. I did a thesis on microwave properties of superconductors. That was a main source of information of microwave properties of materials and cavities and whatnot. So yeah, sure, MIT had a huge reputation, and it was kind of serendipity that I had a chance to join the system. And the reason I joined the system had to do with the fact that MIT didn't have a discriminatory policy against two members of the same family joining a organization. I didn't know exactly about the history of that, how many people before me benefited from that aspect, but it certainly made a difference. So that's why we came to MIT. It really had nothing to do with so much the reputation, except we joined a very good laboratory and we had exceptional jobs in that lab. In the history of science, when you look back nowadays, we have no jobs that were like the jobs that we were offered at the MIT Lincoln Lab, in so far as our obligation was to do basic research and to help people at the lab that needed to know something about solid state physics. What could be better than that, you know? It was kind of an open-ended job. Those kinds of jobs don't exist today.

INTERVIEWER: You mentioned that the nepotism rules played a big aspect in your decision to come to MIT. Who recruited you?

DRESSELHAUS: Ben Lax.

INTERVIEWER: And was there a research project he wanted you to work on in particular?

DRESSELHAUS: Basically, he knew both of us individually from our previous work, and he wanted us to work on things that we knew something about. But I had worked on superconductivity, and Ben Lax had formed an opinion himself that that field was finished; that once BCS theory came along and explained so many things - it didn't explain my thesis, but it explained many other things. And so he really didn't want me to work on that, but most anything else. So that turned out to be a great opportunity. You can look at a decision like that; being hired to do something other than what you knew about as a negative. But this turned out to be a big positive in my career, because I learned another field. And I had from my graduate school experience the background to work in many fields of physics. So this worked out really well for me.

INTERVIEWER: Now you worked in the National Magnet Labs when you came to MIT Cambridge campus, or you were out at Lincoln Labs?

DRESSELHAUS: Well, I was sort of half time at each place. The Magnet Lab, when I was hired at Lincoln Lab was in Building 4 of the main campus, right in the basement. And at that time it was just a laboratory of a professor. It wasn't a national facility or anything, but they had some ideas to make it into a facility. And I was one of the very few people working there. There was a very handful of people who worked with the high magnetic field facility at that time. It was not a big enterprise like it later became. So I was one of the "originals", so to speak, one of the originals.

INTERVIEWER: What was the atmosphere like in the mid-60's? What was the atmosphere like there? Who were you working with when you were at the lab?

DRESSELHAUS: Well the atmosphere changed quite a lot during the 60's. When I joined the lab in the 60's, everything was open, and physics was expanding greatly. That was Sputnik time. And there was a big, big expansion in science nationwide. And I was part of that. My hiring at Lincoln was part of that movement. But in 1964, there was kind of a big change that took place. This was caused by the Mansfield Amendment that said that funding of defense-related research should be related to defense. Well, broadly speaking, everything that we did was related to defense. So that was not necessarily a big restriction, but along with the Mansfield Amendment, there was a part about it that was accountability; that meant different people working on projects had to account for their time. Before that, just the output was sufficient. There was plenty of output coming from the lab; coming from myself and all the other people whom I associated with. So this was never an issue for us. But there was now an accountability of what you did between hour eight and 10, or something like that. And we'd been living with something like this ever since. In some ways it's good, because people should be held accountable for what they do. But in some ways it's bad, because it sort of stifles creativity. You can't be totally creative if you account for everything that you're doing. You need some time to just think.

INTERVIEWER: Now who are some of the notable or memorable people that you met during this early time you came to MIT, whether at the Magnet Lab or Lincoln?

DRESSELHAUS: Well, there was Ben Lax who hired me. And he was a great scientist. He and Gene Dresselhaus were involved with very beginning experiments of cyclotron resonance. So that's how he knew Gene. So he was very happy to have us work on anything connected with that sort of area. And I sort of got moving into the optical aspects of that, which Ben Lax was interested in. So I learned something that he wanted me to learn, and I wanted to learn it too. So shortly after I was hired, for the first six or nine months I was working with him on this project. I was doing semiconductors, just straight semiconductors like a lot of other people. And then I decided I wanted to do something that was a little bit more my own, and I went into doing semimetals. And that was something totally different. Lax had made a bridge to semimetals, but that was just a piece of the action; and I moved on to carbon-based materials from there. He thought carbons were too complicated, but you know he gave me the freedom. He had some confidence in people, and he gave us the freedom. As long as I worked on things that he wanted also, which I did, then he was happy. And I was happy.

So of course, when we look back at what was done, the carbon-related work turned out to be the important work, as history will tell us. But one has to do things that your colleagues need, you know, so that's part of it. So I didn't mind doing that also. And I learned new things from doing it.

INTERVIEWER: Now when you came out from your postdoctoral work and you came here to MIT, was it hard to find a niche in terms of applied physics? Everything in physics with high-energy physics and electrical engineering was just circuits. How did you find this area?

DRESSELHAUS: Actually, when I was out at Lincoln Lab, that was interdisciplinary research. So we had people in all fields working together. And I that was very much like the industrial labs in US generally; Bell Labs; GE at that time was a great lab too, Westinghouse and so forth. They all had similar approaches, and Lincoln was among them and was a great laboratory at that time when Ben Lax was there. And he was there for about half of my stay at Lincoln Lab. And then after he left to become an MIT professor, the atmosphere changed. It changed for two reasons. I think the Mansfield Amendment was part of it, that people had to be a lot more accountable. So the lab started counting beans; a bean counting exercise. And so, many of us didn't fare as well under that atmosphere, but for the most part, the research didn't change so much. It was just the rules that got to us. It was particularly bad for the women. There were two women out of 1,000 men, and this affected us because we had young children, the two women did.

INTERVIEWER: This was at Lincoln Lab?

DRESSELHAUS: At Lincoln Lab. Yeah, Laura Roth and myself. And so we both eventually left, because of these restrictions.

INTERVIEWER: So tell me about this transition from being a researcher out at Lincoln to joining the faculty here on the Cambridge campus in 1967.

DRESSELHAUS: The transition?

INTERVIEWER: Sure.

DRESSELHAUS: The transition, as far as the daily work, hardly changed. When I was a researcher at Lincoln Lab, I actually supervised a graduate student on campus. On campus, there were graduate students, and graduate students were always looking for research topics. For a couple of cases, the individuals sought me out. So I was actually working with some students before I became a faculty member. But when I became a faculty member, I had more students, and then I was responsible for lectures, whereas when I was just a person at Lincoln Lab, I gave guest lectures. So that was the difference.

But the mode of work didn't change that much. It was a bit of a continuum. So the biggest thing I felt was the freedom in time. I didn't have to account for the time. And it was just getting a lot of things done. As a faculty member, you know, you have things to get done, and nobody is telling you what time you do it. This worked much better for me than the system at Lincoln.

INTERVIEWER: Who recruited or encouraged you to come join the faculty, or made the appointment to the electrical engineering rather than physics?

DRESSELHAUS: That's an interesting point. There were several reasons. For one thing, I was recruited by the Department of Electrical Engineering. And recruited is really the wrong word. I was looking for a place that I could spend a little time to do research without the time clock; without the accountability aspect, because getting to the lab at 8:00 turned out to be really difficult for me. So the Rockefeller family had had a faculty fellowship that they started about a year before I had it. I was the second holder of that fellowship, and George Pratt, who had migrated from Lincoln Lab to MIT just before that time, but still spent some time at Lincoln Lab knew my situation and he put my name forward for this fellowship, and lo and behold, I received it. So that changed my career, because I, of course, accepted it. And that led to faculty appointments. I was at MIT for a very short time, and the folks at MIT realized that I would make a contribution to their program.

They were looking for somebody who could teach the students physics from an engineering point-of-view. So having worked at Lincoln Lab for seven years, I apparently had some background that way. So I was hired to do that, but everything else was pretty much the same. The research didn't change very much, and what I was doing was at the interface between electrical engineering and physics, anyhow. And later I got an appointment in the physics department. But in the early days, when I joined the MIT faculty, the physics department had a very, very small commitment to condensed matter physics and was heavily into high energy physics. And the electrical engineering department needed people in this area because materials were very important to devices, so it made sense for me to join the electrical engineering department. It was a good choice for me at that time and continues to the present, because I have a natural place in that department, but also a natural place in physics. Physics later developed a condensed matter program that is quite strong, and so I fit into that department as well.

INTERVIEWER: Now what were your initial impressions when you came to campus in the fall time? You were part time before, but tell me about what the student body was like when you came. I mean, the mid-to-late 60's, there was an increasing number of women on campus. Tell me about the kind of advising and teaching roles you took on.

DRESSELHAUS: Right. Well when I came, there were very few women actually. There were only four percent women, and fewer faculty This wasn't so many, and many of the classes I taught were all male. That is MIT had a smaller number of women and electrical engineering had smaller than average number, so it was a really small number. And because the fellowship that brought me to MIT had something to do with the scholarship of women in science, one of the planks of the Rockefeller Family Endowment for that fellowship was to promote scholarship of women in science and engineering. So I felt that this mandate suggests that I should do something for women in science and engineering.

INTERVIEWER: Was that considered a radical notion at the time?

DRESSELHAUS: No it wasn't it wasn't radical at all. I think it was pretty well accepted. I wasn't a radical. I was doing my job, really, because MIT had the talent pool. We had women here, already. And they were having a hard time, because there were so few. And it was believed at that time that admitting women was somewhat risky, because they weren't doing well. But upon looking at the situation, I felt that it wasn't the women, but it was the environment that they were in that contributed to their sub-critical performance.

So what happened was two things. I was involved with those, but these happenings were welcomed by the faculty, actually. These were not controversial. MIT had had different standards for admitting women than men. I didn't know that, but I found out about this when MIT asked me to be on the committee to admit students. And they had me doing women student admissions only, because the criteria were different. But when I looked at the admission of all students, I saw that it was really quite different. And so the first thing that we did was to have equal admission that would be on the same criteria, academic criteria. That fact increased the women by about a factor two, just overnight.

INTERVIEWER: What were those criteria?

DRESSELHAUS: It was where the cutoff would be on the SAT, etc. component and on the individual assessment. Those were the two criteria. They have interviews and personal characteristics. And then they have performance on exams. And those are the two main topics that enter into the evaluation, and for each of them they had different criteria at that time, some of which was subjective and some of which was quantitative. But it was under the assumption that women weren't performing that well, and many of them weren't. So if they had equal admission criterion, it was expected women would perform worse than they were at that time. But after discussing this among the few women faculty we had at MIT, we came to the conclusion that if we had larger numbers of women, they would do better. That conclusion worked out to be correct.

INTERVIEWER: Tell me something about the other women faculty here on campus. There was Sheila Widnall, Emily Wick, Laura Roth.

DRESSELHAUS: Well, Laura Roth wasn't a faculty member at MIT. She was at Tufts. There was Emily Wick in nutrition. We then had a nutrition department that later became the Department of Applied Biology. And we had Sheila. She was a very junior faculty member in aeronautics. And there wasn't much else in the School of Science or Engineering. I think Sheila and myself were the only ones, and I was tenured, she was untenured. That was kind of what it was.

INTERVIEWER: That was the extent of the women faculty you knew?

DRESSELHAUS: Well, we knew all of them, because there was a woman in philosophy, Thompson, and she had gone to the same high school as I from a long time back. It was a handful of women. I don't know, maybe six or eight. It was a very small number at that time.

INTERVIEWER: Now, would you have meetings? How well did you know each other?

DRESSELHAUS: Yeah, well we got together for lunch over at Ashdown House, every month or something like that. And we would talk. And we would say, we should do something to help the young women coming along. Because when President Wiesner came in, he had the idea of appointing more women faculty. And so we took it upon us to mentor them, because they were in all kinds of different departments, and many had no women. They were the first women faculty, and some of men felt uncomfortable in telling them what they should be doing to promote their careers.

INTERVIEWER: Now the women that you were mentoring or assisting, both at undergraduate, were there women at the graduate level?

DRESSELHAUS: Oh these are the students.

INTERVIEWER: McCormick Hall had just opened up; was an all womens dormitory in the early 1960's. Now did you spend a lot of time working with the women from there?

DRESSELHAUS: None of us spent a lot of time, because we were all working on our own careers. But we spent some time. And Emily Wick was the one who spent the most time, because she was dean of women students until about 1970. And then, when there was a change of the guard. There were some changes, and they had all the students under one dean. But the advising program for women students that Emily Wick had instituted had sort of crumbled at that point. And so the rest of us figured out how we could reconstitute some kind of substitute forum for women students.

So that's kinda how we got involved with that. I'm sure Sheila must have said something about that as well, since she was involved with that, and I was involved also. And in 1970 we started this course, What is Engineering that had some impact, especially on women and minorities.

INTERVIEWER: Tell me about that course.

DRESSELHAUS: Well we had the idea that when these numbers of women students started to increase, the women were enrolling in different departments than the male distribution. So we were concerned about that because of implications of faculty hires, and all of that. We were thinking forward that there someday may be even more women than 10 percent, maybe, which is what we had in, say, the early 1970's; which of course happened. And so we instituted this course in the very early 1970's, like 1972.

The objective was to introduce students to other topics that they might be thinking of for a major. So this was aimed at freshmen, to broaden their insights. We had very interesting people give talks from the engineering School, and we did some of the classes ourselves and some with interesting people, just like you're interviewing people of interest. We did something like that. And it was very successful. Our original idea was we'd have sort of a dozen people that would be kind of like one of the seminar programs. And in the first regular semester, the numbers increased to 100. And so we started running the course not once a year, but every semester. And then we took turns in taking the class, because we did this in addition to the other teaching assignments we had in our own departments. But it was a successful experiment. After four years it was taken over by the School of Engineering. I don't know, about three or four years that we did it, the two of us. And it then became something that had a different character, but it was still a good introductory course for expanding the horizons of students.

INTERVIEWER: What was your reaction to being tenured in 1968? What impact did that have? You had a young family at the time. And your research obligations, was that something you were hoping for, because you were tenured only after a year since you had joined the faculty?

DRESSELHAUS: I was tenured when I joined. My appointment was with tenure, I was a full professor when I was appointed. So it wasn't an issue, and I never asked about it. When they made the appointment, I don't remember any discussions about the levels. We didn't discuss conditions, particularly, and I was around anyway. I just made a transition. It it sounds very odd to you, but I didn't have anybody that alerted me to the idea that tenure was a big issue, so I didn't know it was a big issue, and it wasn't a big issue for me.

INTERVIEWER: Did it change the research? So it wasn't a big issue. You didn't change your research goals?

DRESSELHAUS: No. It had no impact on what I was doing. I just kind of continued. In fact, for the first five years that I was a professor at MIT, I still kept up some of my Lincoln duties, because I was running their seminar, and whatever. I had involvement with various researchers there, so I would spend time between the two places, like a day a week at Lincoln Lab. I think they paid some significant fraction of my salary for the transition period.

INTERVIEWER: So you were named associate department head for electrical engineering in 1972. Tell me about that.

DRESSELHAUS: When that happened, that was a transition, because that gave me many more duties on campus, and I found that I couldn't do those duties plus Lincoln, so I left Lincoln at that time. By that time, Lincoln had already changed quite considerably from 1967, when I came down to campus. So it made sense to focus on campus activities then. And in fact, my husband came down to campus in 1977 when I became a lab director, because then I had additional duties also that were more than I could handle myself. Because I had a very large research group by that time. And he wasn't very happy at Lincoln anymore, because the emphasis on basic research had changed quite considerably. And he wasn't all that happy with what he was doing, so he was happy to come down on campus.

INTERVIEWER: You were also director of materials science?

DRESSELHAUS: That's what I'm talking about. That's 1977. So I was with Lou Smullin until the end of his term as associate department head. And then when he finished his term as department head, it was a new group that came in, headed by Davenport. At that point, he had his own associate department head. When I was there, we had only one department. It was called The Department of Electrical Engineering. The Computer Science component was born during my time. When I was finished, then we had two very distinct associate heads. When I was there, we did have two associate heads, because the department was so huge, and the number of students was so large, that it was too much for one person. So that's the way that went. And so then 1974, when that was finished, I went back to just being ordinary professor and doing my thing.

But my life changed at that time through an external event. I was elected to the National Academy of Engineering in 1974. And along with that came a bunch of different jobs that they gave me to do, so after I was finished with my term as associate department head, I had other duties. So I was heading up the Bureau of Standards evaluation process. That was one of the jobs I got from the Academy. So that was quite a big job, because the Bureau of Standards is bigger than Lincoln Lab. It has a very large number of employees, and the laboratory was divided into different divisions, all of which were evaluated. And I was in charge of the whole evaluation process. So I learned a lot of things; gained appreciation of applications in industry and how industry and research laboratories interacted. I learned all kinds of things.

INTERVIEWER: Let's return a little bit back to when you were associate department head for EE. Now, this is kind of a heavy time for computer science in the late 1960's and early 1970's. Tell me something about how, was it just rumblings or whispers about the AI Lab and the Laboratory of Computer Science; the work that they were doing. Was it occupying a large part of the faculty's research interests?

DRESSELHAUS: When I started in 1972, there were rumblings, but it wasn't a big thing yet. But in the period of 1972 to 1974, you could say that computer science was born. And there was emphasis on trying to think of what a curriculum might be, and how the organization might be. And there were serious thoughts about keeping it within electrical engineering, because keeping the departments, the two pieces together, but having it as two components of the same department. It turned out, in the end, probably, that this was a wise decision. And I say this because other departments were split, like at Berkeley and different places. They brought their departments together again later on. And there were many places that have ECE, so electrical and computer engineering, which is sort of like what we have, electrical engineering and computer science. So the model that we set up was actually followed by other places, but the resources for creating another department came out of EE. So these were kind of difficult times for EE in some kind of way, because they had to do some belt tightening to make CS happen. But that seemed like the right thing to do, to us. So that's what we focused on, and when we look back, it was the right thing to do.

INTERVIEWER: How much did you interact? There's so many kinds of them mythological or strong personalities associated with EECS, between Hal Abelson and Marvin Minsky. There's all these people who were kind of making a name for themselves at MIT during the early 1970's. How well did you get to know them?

DRESSELHAUS: Well I knew them all. The two that you mentioned were in CS, so Bob Fano was their boss, because he was my counterpart on the CS side. But yeah, I got to know all these people. Our policy was to promote the careers of everybody that was in the department, and we put up with lots of people that had independent personalities, shall we say. But the idea was to make it all work, make them happy, but make the the whole greater than the sum of the parts. You don't want to squelch people, because that makes them unhappy and not so productive. And there's enough room in this place to put up with some difficult personalities, and you just have to keep them a little bit reigned in so that other people are protected. That's kind of the way to do it. Marvin Minsky was a great contributor. We had [INAUDIBLE NAME] also. And he was part of it. You know, he's a special personality.

INTERVIEWER: Now when you became director of the Center of Materials Science in 1977, did you enjoy these kind of administrator responsibilities that you had, or was there something about the research aspect, rather than the kind of academic --

DRESSELHAUS: Well, actually, I felt that running the Center of Material Science and Engineering was a better assignment for me than the associate department head. The associate department head had too many personality problems associated with it, you know, people issues. And running a lab had more research issues. So I had a big challenge when I took over, because we were about to lose our NSF block grant. We were in big trouble.

INTERVIEWER: We being MIT?

DRESSELHAUS: Yeah, MIT. And I was brought in to try to save the Materials Center and bring things back, which I managed to do. So it was my job, which I executed.

INTERVIEWER: How did the crisis precipitate or how did you resolve it? Can you go into that?

DRESSELHAUS: Well the NSF was unhappy with our program, basically, and we got some poor reviews from reviewers. These NSF labs get reviewed periodically. And so, we were put on a short string for contemplated termination. Well, I guess MIT wasn't too happy about that, because these laboratories served a very important purpose in providing central facilities for the whole Institute. So it wasn't only the people who got funding to do research, but the facilities that supplied all researchers that were very important. So I had to figure out a way to keep MIT people happy and also keep the NSF happy, which was done.

We all got together, and one thing that I did was I opened up the administration of the center; I involved a lot of young people. And I put a big effort on training future leaders for the center, because I felt that the natural term should be finite. It was kind of influenced by the length of our contract with the NSF, which was a three year cycle. So, I signed up for two terms, but I didn't make that widely known. Just the dean knew that, and the provost. And I kept to that. But I didn't plan on doing this as a lifetime engagement, so my idea was to build up the center, get it in good healthy form, and develop new talent that could be used for other administrative jobs.

See we had a big problem actually at that time, that during the War Years, lots of people were trained and became good at running things. And then they were running things, and the young people didn't get the experience, because the other guys were running things. So I recognized that this was an issue, so I put an emphasis into training people. And those people have gone on to do many things at MIT. So it was a good thing.

INTERVIEWER: So you finished up your post there in 1983 and you were also named physics faculty.

DRESSELHAUS: Yeah. What happened with the end of my term was a little more complex than what you said. What actually happened was in 1982, or the fall of 1981, I was elected to the American Physical Society to become President. The Presidency was assumed in 1984, but then I had a couple of years that first, oh I don't know, you have names for Vice President Elect, Vice President and so forth. You have different stages of this. But I became busy with that, and I kept doing all my teaching during all these years, whereas other people might have given that up. But I kept that on, and the reason was that we had no women teaching, almost. So for many students, I was the only female faculty member. I felt very strongly I didn't want to give that up, so I was doing too much at that time.

INTERVIEWER: What classes were you teaching?

DRESSELHAUS: Well, solid-state physics of various varities to the engineering students. But by that time, I had physics students as well.

So we were talking about the Center. We're now sitting here. This place here used to be an ion implantation facility, this very room. And then after a while, the number of uses decreased, as this became sort of a standard thing elsewhere. So we made a conference room out of it, which has been greatly used.

INTERVIEWER: You also became associate provost, right?

DRESSELHAUS: No, I never was. That's not right. Starting with the American Physical Society, then I had many jobs elsewhere. So I became treasurer of the National Academy, and so lots of things like that.

INTERVIEWER: Did you ever have aspirations for any higher leadership posts within MIT, or did you find the ones outside MIT --

DRESSELHAUS: No, in fact, when I was asked to do various things, because I was asked to do different things, I can't remember all the things, but I didn't want to give up my research program. So most of the higher administrative positions required strong compromises with how much time I would have for doing research. So I just didn't seek that, and I was busy enough doing service to society and the research community, generally, with all the stuff I was doing outside of MIT. So I was quite saturated.

INTERVIEWER: Your research covered electronic structures and various materials, intercalation, ion implantation, and then novel carbon forms, nanotubes, and now thermoelectricity. Is there a common thread through all these, an underlying interest?

DRESSELHAUS: It's all kind of, well, we started out with these carbon systems in 1961, and that soon led to nano-things, because in the early 1970's, when we started working on intercalation, that was a way to look at individual layers at the atomic layer. So I was into nano-stuff in the early 70's. And so everything that you mentioned has to do with nano. Thermoelectricity was a new idea that came to me. For 30 years, from 1960 to 1990, there was essentially no advance. The navy was interested in developing some kind of better thermoelectrics for submarine applications, that was their main interest. And they asked me if I had any ideas, so I said, well, we have all these new materials around now, nano-things. That could be interesting. I looked into it, and it looked like it would be very interesting. So we had a new field.

That was one field that I started and that I stayed with through its development, or much of its development now. Now, there are so many people working in it, so it's hard to find new things. You can't be in every field, fully. The carbon one, as that developed, went to nano structures, with fullerenes, and then nanotubes and graphenes. We have more things coming down the line, probably. So that's a natural for me. I stayed with that one all the time. And thermoelectricity I work on also, but to a lesser degree. And then there were other fields that we started that other people have taken over. So that's okay. You can't do everything. Coherent Optical Phonon Generation. I was doing an experiment with Eric Ippen when we discovered that field, and we wrote some seminal papers. But we couldn't get any funding. The time that that happened was just right after the Berlin Wall fell, and we were in kind of a bad situation in funding physical sciences; there was a recession in funding. So other people followed on with that field. We couldn't get funding. We started the field, but we couldn't get funding to work on it. So these things happen.

INTERVIEWER: Maybe you could explain in sort of lay terms what the fields broadly that you're interested in are, what intercalation or implantation or any of the kind of nanotubes; any one of the many disparate things you've become involved in. What's your favorite or --

DRESSELHAUS: They're all nano-related. So intercalation is the insertion of layers, one layer at a time of course, so let's say one layer, of a guest species into a host material. So it is nano in the sense you have one atomic layer. And then you can follow the properties of that layer, how it changed the host, and how it changes what gets inserted. Both of them change, obviously, through the interaction. And that's interesting. So that's one field that we kind of were into at a very early stage, and I stay with it as that field developed and went through its crest and became less important. You know, as these fields come and develop they sort of go through some kind of maximum, then they dissipate a bit. So I was involved with that whole process. But something like the nanotubes, that started a long time ago, because we've seen nanotubes in high resolution SEM images a long time ago, but didn't pay any attention to them.

INTERVIEWER: Tell me about your metallic versus semiconducting investigations in the nanotubes.

DRESSELHAUS: Yeah, well what prefaced that was I gave a talk at a conference, and saying what would be really interesting is if somebody could think about what properties nanotubes might have as individuals, just one layer of them. Because that was like intercalation where we had just one layer. But now we have it wrapped up. And the idea was that an object like that could have very interesting properties. So I made a talk about that the structure would be very novel. And then I sorta sketched some interesting projects that we could work on in that field. So this was kind of a talk at a conference, talking about nanostructures. It was a fullerene conference. So you can imagine that a nanotube is built out of making bigger and bigger fullerenes. That was the way I presented it at the time.

So people seemed really interested in this. I saw different people scribbling lots of stuff down, so I said gee, maybe this is interesting. So I had a visitor who arrived like one month after I gave the talk, a theory person who was doing a sabbatical here from Japan and said I why don't we work on this and see what the properties really are, instead of giving the problem away to everybody else. Let's do it ourselves. So then a second Japanese guy on the same fellowship but from a different place, and they didn't know each other came by wanting to talk to me about projects that I thought were interesting. So I suggested this to him too. And I said, oh maybe the two of you might enjoy working on this together. So that was the beginning of this. That's how this thing was born.

INTERVIEWER: What's come of it?

DRESSELHAUS: Well, lo and behold, about a half a year after we published our paper, making the prediction that these kinds of tubes would be especially interesting, because you meet properties that they had. Somebody soon figured it out. Two groups at IBM and NEC figured out how to actually make these nanotubes. But it took six years between the time that they were discovered and the experiments were done to show that our predictions were correct. Part of the reason is, when you have a new kind of material, it's hard to control and hard to make it reproduceably. The amounts of material available were so tiny that the appropriate experiments couldn't be done right away. So it took a little while.

There was also a non-believing community out there. The research communities are always very conservative. They like to believe what has happened before is correct. And when you come up with something that's revolutionary and new, they don't like this. So until the day we publish the paper, there was mostly unbelievers. Then of course, when you have the smoking gun, then it's all over. And after that, there are no non-believers, but there is total conversion.

INTERVIEWER: Now, you've seen many fads in the materials science and applied physics come and go. There's the hot talk of high temperature superconductors that they're always just around the corner. Now we talk about nanotubes are going to change everything and whether or not that plays out has yet to be determined. I wonder if you had any thoughts about what role the hype has in securing research funds and sheer basic research versus sort of promoting false hope about it.

DRESSELHAUS: Yeah, well, hype is bad, because hype builds up false expectations, and then eventually you're caught. Because if you hype something, it's never going to be quite as good. You have to, I think, be pretty honest, about what the time scales are going to be. And I think that we have to be very careful, because we were burned by these high temperature superconductors. I think at the time that they came out, people really believed that making these would be pretty easy. Because you know that the one thing about High-Tc superconductivity that was interesting is that the recipe that was given, anybody that tried it within a few weeks could reproduce it. So it wasn't so elusive. Most other things that are in the condensed matter realm are difficult to reproduce, especially if they're not correct. It takes a long time and then people find the truth. Well like this Schoen thing that we heard about conducting polymers. That false announcement kind of killed the field, because that's worse than hype. That's false results, false data. But even hype is detrimental because it builds up false expectations. So we should be careful not to do this. I've been involved in a whole bunch of different national studies, and I try to call it the way I see it and not to exaggerate. But I could understand why there was hype in the case of the High-Tc, because people were so excited about the fact that we had - superconductors go up to 23 degrees kelvin with great, great effort. And then all of a sudden it went up to 40 and 90 degrees in six weeks. It was unbelievable that something like that could happen, and that everybody could reproduce this. So they thought this field would be easy, a piece of cake. But it turned out it wasn't like that. Control of materials and the engineering aspects turned out to be a lot harder than anybody ever imagined. And the theory has turned out to be a lot harder too.

INTERVIEWER: So when it comes to these sort of basic science concepts, whether it's high temperature superconductivity or fusion or these ideas that are very much rooted in basic science and trying to apply them into realizable technologies for society, they almost always somehow end up being disappointing, whether or not they don't deliver on the right time scale or don't realize the expected gain.

DRESSELHAUS: But there's no delivering on a time scale, because research just doesn't work that way. There are breakthroughs. So High-Tc was a breakthrough. But then the follow up part has proved very, very difficult. There are many interesting things that come out of this on highly correlated systems that are interesting to a physics afficionado, but people thought there would be industries, gigantic industries, flowing from with the kind of money that was put into it, initially, by industrial labs and the government. All governments, not only US labs.

INTERVIEWER: Is it a question of not having enough basic research dollars or not having enough industry interest? Does it just vary based on the varying sciences?

DRESSELHAUS: Well, we go into things in a big way, you know, in the beginning with great enthusiasm, which is fine. That gets a lot of things discovered. And then, of course, it's shown that this is really a hard problem and a sustained effort is required to make further progress. Lots of people back out at that point, but there are a few that would like to continue, and it's very hard for those people to find funds. So we need some funds for those people. So we go too big, and then we go too small. We have this spike and then we undershoot. High-Tc will find some kind of place. There'll be some kind of applications. We have a few now with interference filters. We need more than that. I think it will come with time, but who knows? The LASER was a little bit like that, but that wasn't hyped up. So people weren't expecting big things, and now we have lots of applications from lasers. But it took a long time before the applications came. Quantum mechanics, another good example took a long time. And that wasn't hyped up, because nobody thought that that would have applications. But High-Tc seemed like a natural for application, but the applications happened slowly, and nanotubes seems like an obvious one too, but it's more difficult. I think nanotube applications are coming. There are companies now, that are forming. And High-Tc companies, well there's American Superconductor. They've done pretty well, actually, as a company. They've survived. It hasn't become another ATT, but look what ATT did. They went up, and then they came down.

INTERVIEWER: You've been awarded so many honorary doctorates and awards at the national level, as well as holding positions in the American Association for Advanced Society, or APS. Is there something you feel like you haven't accomplished yet? Do you stay up late on Octobers waiting for phone calls from Stockholm?

DRESSELHAUS: No I don't, as a matter of fact. I feel I've been more than honored. You know, I don't do science to get honors, so anything that comes along is a big surprise to me. Every one of them has been a surprise, and I haven't looked for anything. Actually some of them, they give me opportunities. Like this last one, with L'Oreal, with women in science. That was a little bit, well not totally unexpected, because people would talk to me about it. And because I knew the other winners, they would say to me, how come you don't have this prize? I said well, I just wasn't awarded that prize. That was my answer every time I was asked that question, but then eventually I won. But the point about that prize that's changed me in some ways is that I feel like I ought to be doing something about it, because the L'Oreal company, they put a lot of money into advancing women in science and engineering worldwide. And I understand why they do it, because it's good for their business. So I can understand that aspect. But for me, I don't really care about their business, but I care about the principle. And they're always looking for some kind of ideas. So if I can furnish some ideas, then we make a good team. So that award is a little different than some of the others, where you get the award and that's the end.

The award from the Heinz Foundation was another one where I felt it changed me somewhat in thinking about what the applications of my science could be good for. So sometimes you get an award that has an impact on you, and then all the honorary degrees. That has the following things happening, because all of these different universities consider you all of a sudden as an alumnus, and they give you jobs to do. So it isn't that it's an event that ends with the day of the award, with those kinds of activities.

So I guess that the awards have one impact on me, making me feel that the work that we do in science has some relation to society. MIT likes that, actually. They encourage us to do that, so I think I'm in a good environment for this.

INTERVIEWER: I was wondering if you could tell me, you straddle three very distinct silos, or areas at MIT. You're on the interface between electrical engineering, physics, and materials science, which are all very renowned and notable programs, have been at MIT. Was it hard by coming in, or hard now finding a niche? Or did you thrive living on these boundaries, or is sort of interdisciplinarity something that excites you?

DRESSELHAUS: Well it was very easy for me. Between electrical engineering and physics was easy, because I was part of both departments. And even before I joined the physics department, I had many, many graduate students from physics, and I was involved with their things, even if I wasn't a member of their department. Then I became Institute Professor, so that really straddles everything. But I didn't really need Institute Professor to straddle these things. When I ran the Materials Center in the 1970's, that straddled all the departments already. And my research is really at the interface, and what's happened over time is that departments have actually grown together. There's a lot more overlap between them. Overlap between them, and also the special roles are more distinct, so I would say that the condensed matter physics side of physics is done mostly in the physics department, with some transitions in other departments. That's really very heavily focused. The applications are in EE, very strongly focused. And the material physics is strongly in the materials science department. And what has happened is that the materials science department has become much stronger over the years in materials physics, certainly a big difference over what it used to be.

INTERVIEWER: When talking about thriving on the boundaries between various departments at MIT, and I was going to ask now what merits or benefits are there, and the associated costs with exercising interdisciplinarity within the curriculum versus emphasizing developing strong technical roots. Should all MIT students, you know, develop computer science and materials science? Should they all have their fingers in all these various aspects? Or should they --

DRESSELHAUS: Our curriculum has a first year that's pretty common for all MIT students, and many common elements. And I think that that's very good. When you compare our students to students coming from other institutions, our students have a very strong base in all the different sciences: physics, chemistry, math. They have a computer science requirement, a biology requirement. They have a strong grounding in many things, because those so-called elementary courses are not all that elementary compared to what they have at other places. I think that that's good. I'm talking about the input.

Now let's talk about the product that we're thinking about. If you're thinking about a research career, which is common to many of our students - not all, but a large number - then the big opportunities seem to be at the areas between present disciplines. How do I know this? I have various inputs. I just chaired a national study on condensed matter and material physics. Every 10 years we have a national study in important science fields. I was involved with one before the present, and then the present when I was a chair. The one I was involved with was two times ago in the 1970's, so I missed one. But anyhow, in doing that survey, it is evident that many of the exciting areas are newly emerging fields that are between different areas of physics, like condensed matter and atomic physics, Bose-Einstein Condensation, those kinds of topics. And that's forming a whole new sub-field of physics. That's important. Another sub-field that's very prominent is the biophysics sub-field. And doing this study showed these to be areas where there is very exciting research. It's just coming to the fore. And so somebody would ask me where we should hire in those areas, and in fact, the department has been doing exactly that. They didn't need the study to tell them, which is very good that we anticipate some of these things here.

The other piece of evidence I have is, I've been on the Packard Committee for Faculty Fellowships, a very distinguished program that we have nationally. And for the last few years, last five years, the interdisciplinarity has been sort of a common theme. The very best candidates, the brightest stars in our country are working in these fields. And they just stand out above the other people. So all of these bits of evidence tell me that this is an area that are an organization that MIT should emphasize also. But if you're going to be strong in these fields, you need to have some solid foundation as well. So teaching in the disciplines is useful. But then we should promote interdisciplinary activity as well. And some of that has to come out at the expense of some of the disciplinary work, because you can't in the fixed number of units that we allow the students, 45 units a semester or whatever, that's a fixed number. The students can only assimilate so much information per unit of time. So some of that should go into new areas, new developing areas. We had biochemistry, and we had different things that we can look back. Well, electrical engineering came out of physics 100 years ago. So, now we can look at that.

INTERVIEWER: Building on this, to what do you attribute the emergence of biotechnology and nanotechnology, information technology, neuro technology even, and the decline of traditional engineering and physical science disciplines? Is this a natural ecology of ideas, or is this something that we as a country or a university should be concerned about?

DRESSELHAUS: Well, it's a little different than you just said, I think. I think that in one sense, we're bifurcating and developing these different fields at the fringe. But there's another thing that's happening. The fields are also coming together. Just think about mathematics. They used to be bifurcated into more and more fields. But what they find now is it's more and more important to have a knowledge of the entire field, because we don't know which combinations of things are going to be important in the future. So for me, I had good training across all physics fields, sub-fields. And that turned out to be very, very useful when I was working for the government, heading up the Office of Science, for which I was responsible for a very broad area of science. That went beyond physics. I had biology, chemistry, and all these other things, materials science. So having a broad knowledge was very, very useful. And so you think about the students who come to MIT. Some of them go into research. Some of them go into business and other walks of life, and they make use of it. Those are the students that really need to spread, because the make use of a very broad exposure. So yes, we should have depth, but we should have breadth.

And I don't see that they're contradictory, because the disciplines themselves show new aspects within the disciplines that wouldn't be appreciated unless you go through this process of breaking down to different pieces, and then putting the pieces together. I don't know if that makes sense to you. But that's exactly what's happening in the fields now, is that they're going into different directions, but they're coming together; both are happening at the same time.

INTERVIEWER: So perhaps on that note, someone said that MIT is full of these scientists and engineers who are also artists, that there's this element of - and you, yourself can relate, because you grew up playing the violin and viola, and it's something you still enjoy - but what role do the humanities, arts, and social sciences have at an Institute of Technology? How have your paths intersected with humanities at MIT?

DRESSELHAUS: Okay, that's a good question. And I wanted to preface that by something that MIT did when I first came to MIT. Because you asked about some of the early days. The Research Laboratory of Electronics sort of grew out from the Radiation Lab, you could say. Somewhat related to that. And they used to have a seminar going, but Jerry Wiesner, who was one of our presidents in the 1970's, he and Walter Rosenblith are probably in those interviews that you must have on tape, would go into this in great detail. They had these seminars that cut across all these different fields, and people would go to them and be simulated.

So they had people like Morris Halle talking about Linguistics and so forth. But that makes a contribution to fields of science as well. It's not unrelated. This gave people the idea that liberal arts, and being able to appreciate fields outside of science things, and bring that into science, or interconnectiveness, was an important part. Because if our students or graduates couldn't communicate with the rest of the world, that would be pretty sad. Science is good when people know what you're doing, and it's not only for other scientists. You have to communicate more broadly. And to do that, you have to appreciate what other people consider important. So some knowledge of the humanities, I think, is a very good thing. And our students, by and large, don't appreciate it as much as they might.

At other places, science students pay more attention to the arts and humanities than here. But our arts and humanities somehow try to go out of their way, I think, to make some contact with the students that we actually have. I know this more about the music department, because you mentioned my interest in music areas. I'm a practicing amateur.

So I have had for years, ever since I've come here, they send me students that double major between like EE and EECS, and say certain humanities, especially music. And we have a program, you know, music. They get lessons from people in the Boston Symphony or whatever. And they have to somehow manage that heavy time commitment together with the heavy time commitment of MIT undergraduate education. So I guess students like that. And the amazing thing is, those students tend to be straight fives, or very close to it. And I don't know exactly how they do it, but the people in the music department always tell me how great those students are in their music field, but they're also great in electrical engineering. They're just very, very good students. But to me, it's a big challenge, because how to make a career that combines fields that don't seem connected is not easy. Like, when we were talking about the sciences and how they are inter-related, we understand that. And there are many good examples of how new science develops from that. But new science developing from the interface between the arts and science is less obvious. And we have fewer connections of that, right now.

INTERVIEWER: How has music influenced your research at all? You've done work on phonons.

DRESSELHAUS: No overlap. Phonons are usually very high frequency vibrations that are way, way beyond any audio response. I think that for me, it's just mostly relaxation and meeting people that are outside my field. It's sort of like that. In my early career, most of the years I've been at MIT, my music activities were, you know, one day a week I would sort of splurge and do a lot of it. The rest of the time it was not too much music. But more recently, I guess in the last 10 years. After age 60. I think it started when I was treasurer of the National Academy, and I would spend quite a bit of time in Washington. So I felt when I was home, I should have some more music at home. So I think that was part of the change in my emphasis.

INTERVIEWER: Now during your lengthy tenure here at MIT, you've served under many presidents. And you served during a period of time which Walter Rosenblith what called Camelot at MIT. He defines it as a period between 1966 and 1990 when we had President Johnson, President Wiesner, President Gray, all served in succession. They came from very similar backgrounds and were closely connected within each other's administration. And they persisted at MIT after they served as president as well. And I was wondering if you could comment at all on the kind of similarities or differences in their styles or philosophies, the ambition you saw for the Institute.

DRESSELHAUS: Yes, they had very much similarity. And yet, they had very many differences. During the Johnson administration, we had turmoil. That was the time of Vietnam, and students worldwide were kind of up in arms against traditions and what we were doing in the present. And his administration focused on that. And after that, when Jerry Wiesner took over, that was pretty much finished. And we were in an era where a visionary, Jerry Wiesner was our leader. And he expanded the operation of MIT way beyond anything that we had ever dreamt before. So we had the Media Lab. His idea was, that was kind of a science in society type thing. It went into many, many areas that were beyond what people had in their own minds. So when we were here, I thought, you know, we're really going well beyond what we ever thought about before. I talked about women and minorities. He did that as well. That was one that I understood. So that was easy for me. But the Media Lab was a little bit less easy and some of the other expansions. I think that we look back at that administration, and we needed the time of Paul Gray, who was a consolidator. He didn't start so many new things, or maybe he did, but it seemed that he kind of consolidated many of the disparate things that we had going in all different directions that were maybe not coordinated so well. And when he left, I thought MIT was working pretty well.

We would have had Phil Sharp next. He would have been another one of ours right? He'd been professor here for a long time, and that wasn't to be. But it almost happened. And what Chuck Vest did, since he wasn't an MIT person, he had to find his niche. And so he was bringing something to MIT that he thought we needed that we sort of had. And this was the internationalism. And he extended us into US science policy in a very big way. We kind of had that with Jerry Wiesner. He just didn't make much of it. But we sort of had that. We had John Deutch here. He did that sort of thing. We were doing it, but less officially and less organized. But Chuck Vest had, I think, a big impact on that. I think in a positive way. I think most faculty would like to see more of that continued. I think we flourished under Chuck Vest.

And now we have new administration, and I don't know. It's too soon for me to be able to evaluate exactly what we're doing. What we're doing that's different than any time before, is we're organized in some official new university-wide challenges, like energy; energy and the environment. And we have to see how that goes, whether we can have an impact in the field, and whether organization of activities from the top, which is kind of the way this thing went, will work out as well as in the past. The organization had been a lot more bottoms up type thing. We certainly need to be in the areas that the new President Hockfield is finding for us.

INTERVIEWER: You mentioned MIT's prominence on the national, international stage; that some prominent setting national science and educational policy. But how should MIT balance its obligations as a world class university with national priorities where it comes to setting these sort of national policies?

DRESSELHAUS: Well, I think that we should have a large role in that, because that's a natural for us to do. Because we've been doing it. We've been doing it well. We're looked upon doing it. And I think that brought us international prominence. And I think it's been a source for attracting the very best students. Everybody knows about us every place we go. And I think that's a good thing for the Institute.

INTERVIEWER: But given an increasingly international student body --

DRESSELHAUS: Well I wouldn't say that we're internationally increasing. I think that when 9/11, we're not probably increasing. I think that we're probably maintaining. You know, the Europeans are now emulating what we're doing. 10 years ago, they didn't have many foreign or, certainly, Asian graduate students. In European universities, you didn't see them. And now they have some. So we've had an influence on them. In some sense though, we've lost some of our own, because we could attract anybody we wanted before. Now we have more competition.

INTERVIEWER: Are there things we could be doing differently in terms of --

DRESSELHAUS: Well lots of that is beyond our control, because of what's happened in the federal government. We have all these restrictions. We know that, because our graduate students are not as free to travel now and do things with collaborators, as they once were before. Because they're held back home. They can't get back to the US easily. Even though we try to make all plans for them to be able to come and go easily, it doesn't work out perfectly.

INTERVIEWER: Let's rewind the tape a little bit and go back to the late 1960's. When did you start seeing sentiment among students, as well as faculty change, in terms of changes in how they dressed or hair styles to the number of protests that were on campus. And just the social movements, whether it was Civil Rights or Women's Rights or the environment, or antiwar. There were so many things going on at the time. When did you start to see these things really take root in the 1960's leading up to the spring of 1969?

DRESSELHAUS: Yeah, well, that was kind of a worldwide thing. It wasn't a MIT thing. I would say that at MIT, it was pretty tame compared to what it was in general, because some places they just disbanded education. It got so unruly, it was hard to keep classes organized. But here, students went to class. They protested, but they did their studies. I was teaching them at the time, so I can vouch for that. Maybe they weren't as attentive in some classes that they were less interested in. I noticed that, because they had to find time to do these social activities. And that's where it came from. But later on, these people that were involved in all of these kinds of protest movements, they became quite tame. Because some of them I met later in life, and they were different kind of people. It was just like the people who didn't participate in those movements.

Was it good for the country? Yeah. I think it's always good to have some motion and activity.

INTERVIEWER: Were you at all sympathetic? Did you become involved in any of the protests or the walkouts or anything like that?

DRESSELHAUS: You know, the position of a faculty member is not to take sides but to be ecumenical and accepting of everybody. So a student that was involved with activities, I treated them the same way. I thought that is always the fair way to go. If I had to do it again, I would do the same thing. You have to stay outside of these individual things as a faculty member. Because if you start taking too many sides, then it's hard for the students to relate to you. That's not a good position.

INTERVIEWER: Can you tell me what the atmosphere was like in the spring of 1969, and into 1970, when there were widespread protests, walkouts. They were breaking into the president's office. There were bombs going off at Draper Lab. Tell me what what's going on?

DRESSELHAUS: Well, yes all of these things happened, but it wasn't so dramatic as you portrayed it. Yes, these things happened, but they didn't involve all the students. There were many students who were here doing their regular thing, as well. And yes, the president's office was invaded, but compared to other places, it was very tame here. I don't know if you appreciate that. It was amazing. Students had these arm bands that they would wear, so you knew what they were involved with. And then they came to class, and they did their homework. And it wasn't that different, in some ways. Technical courses went on pretty much like they had always done. And there've been other times. When I think about the war years, young people were in charge of major things. You didn't have to be 50 years old to be in charge of something. You'd be 20 years old, that was enough to be in charge of major things. And so what I saw happening in the 60's was some of that spirit of young people realizing that they had something to offer. And they weren't being heard. So, okay, make some noise. You know, in some ways, we've had revolutions of this sort continuing. The Information Age, when that came along, young people are better at some things in technology than older people, because things have been changing with time. And they grew up with it. And, so we see these kind of changes. It's not revolutionary. They're not taking over the president's office. But they still have a leadership role in things, even though their age is young. I don't know if I made myself clear to you. But we have different revolutions taking place in different eras. And sometimes it's more of a political nature, and other times it has a technology side to it.

INTERVIEWER: Sure. Now the early 1990's. MIT's staked out. What were, on an ethical and moral frame, very justifiable, but become socially and politically controversial positions, whether it was student life or student financial aid or --

DRESSELHAUS: Student financial aid was a big issue that MIT took a very special and strong position. They invested quite a bit of money in it too. And they got national prominence. But in the end, that turned out well. And I think everybody has MIT to thank for a more rational approach.

INTERVIEWER: Whether it was the Women in Science report that came out in the late 1990's --

DRESSELHAUS: Well the Women in Science report that came out, there were a whole bunch of Women in Science reports that came out that were grassroots motivated. In that report, the Women in Science one, from the faculty had a grassroots origin. It wasn't something that came from on high, but it had a grassroots origin that attracted attention by the administration, and some level of support. Once they did some investigation themselves, they thought it had some merit. But that had a big import impact on the whole country, the whole world in fact, because things have changed elsewhere too. It's not only in the US, and it's not only MIT. A lot of it started here, but it was ready to happen.

INTERVIEWER: What was your involvement in the Women in Science report?

DRESSELHAUS: I was involved with the early side of it, when the women first got together, before there was any organization. My position about it was that I had led the 1970's organization, you know, when we were trying to recruit women and provide support for them. So I was very active through the 1980's until I was president of the APS. So I felt that I had done my thing, and I said it was much better for the next generation to take over than to have the old timers do this. And I still think that was the right approach, because we have to keep developing talent for each generation. So I was involved in the early stages a bit, and I would be called on for different aspect of it now and then, but there were other leaders that took over that were in the appropriate age group of active senior faculty.

INTERVIEWER: Now you mentioned when you had started at Lincoln Lab --

DRESSELHAUS: In 1990 I was 60 already. So I didn't think that was the right age group to be involved in something like that, in the leadership aspect. Just supporting.

INTERVIEWER: You mentioned when you started in the early 1960's or mid-1960's that being a woman wasn't a handicap, because there's such a great need for qualified scientists to do basic research in an exploding job market. Through years did you, yourself experience discrimination? Overt discrimination?

DRESSELHAUS: Now and then. But I would say that with time, there were fewer and fewer incidents with it. The big change that occurred, and it must have occurred some time in the mid-1980's, when the men themselves kept coming to me to find ways of getting more women involvement in science. Before it was up to women to do something. But then, it was was all of our problem. And that came in the mid-1980's, and I think that has made a big difference. It's going to be some time before we have equal numbers of women in the sciences. I don't know whether that will ever be, but as students now in graduate school, in the undergraduate programs nationwide, there are large numbers of women in undergraduate degrees now.

DRESSELHAUS: Certainly within MIT programs at the undergraduate level, like biology or chemical engineering or biological engineering, there's always this, you know, whether it's from Lawrence Summers up the river, talking about innate differences. There's still this sort of underlying --

DRESSELHAUS: But look what's happened. The reaction was, there wouldn't be a woman president at Harvard, probably, if not for Larry Summers. I think that was a reaction against some of his comments. Somebody interviewed me right after that. I predicted that it would turn out like this. There were some formal comments I think I made to the press, that the outcome would be opposite. Because the remarks he made outraged men. In the past, remarks like that outraged women, but now they outrage men also. And that was the turning point for me.

So there would be more things happening, positvely, formal things happening at Harvard for women. And there would be more appointments for women. I saw that coming.

INTERVIEWER: Does that sort of mindset reflect the mindset that was present when you were rising through the ranks when you were a younger faculty member?

DRESSELHAUS: Well, I was saying, in my early days, we had very few women. And there were just individuals who felt that more equality was a good thing. Most people were kind of nonchalant, not interested. But then, what happened is that their daughters starting getting interested in careers, and that made all the difference. I think that's what turned it. It takes a while for this to happen, it takes at least a generation. In fact, the progress of women in science has been faster than anything I would have expected. And it's because it's a cooperative effect. Mutual things have happened that made it happen.

INTERVIEWER: I guess we're moving into the home stretch now. I want to ask some broadly reflective questions. What about MIT sets it apart? What makes it unique? Why can't other universities imitate its success? Is it something about the administration? The faculty? The student body? Research that it does? What is it?

DRESSELHAUS: The whole thing, I think. And also some of the history. We attract some sensational people, and I think that we're willing to take risks in appointments. And I hope we continue to do that. Because we don't always know how things are going to turn out, so I believe the faculty really is the thing that drives MIT to begin with. And the students that are attracted, because the history and the faculty and the programs and UROP. UROP, when it started, was not understood. There was undergraduate research, but to have many students involved with it and to have it as the norm rather than the exception, was something that took many people by surprise. And I think that Jerry Wiesner was a big factor in promoting this when we had it, and giving it some resources so that it could take hold. And then they got grants and interested alumni.

INTERVIEWER: Speaking of UROP, how well did you get to know Margaret MacVicar?

DRESSELHAUS: Oh I knew Margaret MacVicar really, really well. Margaret MacVicar was a person who had great problems at MIT. And it took her a long time, because she was not going along the beaten path, and her contributions as a faculty member were just not straight research but for having ideas far outside the box and implementing them.

INTERVIEWER: Did she come to you at all? She's remembered for being instrumental in getting UROP started or off the ground, at least to some respect. What involvement did you have with her on that?

DRESSELHAUS: I had a lot of involvement with Margaret. She used to come talk to me frequently. We were in similar fields. And we had some common background, because she was a student at Cambridge. And I also was many years before her. Margaret just had a lot of problems. She liked to have somebody to come talk to. So I was recipient of information sharing. You know, she was an early faculty member. She joined the faculty, roughly the same time as I did. Much younger than me, but still. And I was a senior person, so I could give her some advice or whatever discussion, shall we say.

I think UROP went far beyond my expectations.

INTERVIEWER: Because those numbers who participate, or the products of it?

DRESSELHAUS: Yeah, that it would be so successful as an educational tool. And that it would benefit as many students as it did, and that we would figure out a way to accommodate them in the programs and all of this.

INTERVIEWER: It seems that so many MIT students have this basic kind of natural imperative to tinker or hack or just experiment. Does this tap in to that natural reserve?

DRESSELHAUS: It really does. It really does. It gives us an organized way to develop with some training. I did something like UROP with my own children. I brought him to the lab and had them mix with the graduate students. And that experience in the early 1970's helped me to appreciate what UROP could do for even pre-college students. So she was kind of right about it. It is an organized way to developed tinkering. And it's good for the graduate students to have some younger buddy to supervise and push around a little bit. Good family-type building.

So you asked about what makes MIT unique. I think it's experiences like that that make MIT unique. But in some areas, MIT hasn't done as well as it should, like for example, organizing a nano program. Whereas many others like Harvard, down the street, has a very nicely organized nano program. And we have lots of nano people here, but we're not organized so well as many other places. Northwestern, I can think of and a whole bunch of other places.

INTERVIEWER: Derek Bok, who is a former president of Harvard mention in his 2007 commencement address that looking forward, that universitites would have to decide which kinds of sciences they want to excel in, because the cost of doing both basic and applied research is that the costs are rising so high, you're going to have to decide to pursue a nano track or a bio track or something like that; that universities can no longer afford to just do everything and do it well. Is that a view that you share, or should MIT or other universities still try to support across the spectrum?

DRESSELHAUS: Well MIT is a university that focuses on science and engineering, so we have to have at least some breadth to our activities, because that's really what we do. But we can't do everything. But we should do the important things. And I guess that sometimes organizing along some themes brings facilities and brings support nowadays. I look at a few places that we missed out on, and that's one of them I would say. We just didn't have a local champion that did it, and Harvard did. I think that they had Venky there and he played a large role in making that part happen.

INTERVIEWER: Now your professional commitments still figure largely in the things that you do as the president or chairwoman of --

DRESSELHAUS: I'm chair of the board at the American Institute of Physics. Is that what you were referring to? Well, this is my last year with them. I'm finishing my five year term.

INTERVIEWER: How do you enjoy that? What are your responsibilities there? What are the projects --

DRESSELHAUS: Well that's kind of a fun job. One of the MIT professors responsible for doing that, Jerry Friedman, who is another MIT person that I'm sure you've interviewed or should interview in this series. He was chairman of the committee that nominated me.

So what I thought was that the different professional societies can do a lot for strengthening the physical sciences, including physics. So when I went into the job, that was what I thought my role would be. It's sort of like what Chuck Vest was doing, but from the society side of it. And then when I came there, what I found is that we had a revolution taking place in information technology affecting publications. And that was such a crisis situation that that required full attention.

So you start something with one idea in mind, then you do something else, because you have to survive as an organization. I think that the pressure on how we disseminate information is still going to be a major initiative and responsibility for the person that takes over from me. We haven't settled, even after five years, because this happened my first year in office. And even after five years, we don't really know where publications are going. To what degree of the journals as we know them now, they're mostly online. They're getting more and more online. But how's this all going to settle, and who's going to pay for it? That's not worked out, and until that gets figured it out, these jobs are going to be very challenging.

INTERVIEWER: If you saw yourself 25, 30, 50 years ago, and based upon all experience you've had since --

DRESSELHAUS: I never would've dreamt I would have done any of this, so it's all a big surprise to me. And I take each new opportunity with enthusiasm. I enjoy all this. But I really enjoy doing science, and I'm still doing that. That's my main thing, and I do these other things a little bit on the side.

INTERVIEWER: What advice would you offer to young up and coming physicists and others scientists who are longing to do research or academics; or other young women?

DRESSELHAUS: It's a wonderful career. It's such a great career, I couldn't think of a better career. Now it maybe doesn't pay as much as some things, but the other rewards are so fantastic. I really have enjoyed working with the students, and I've had a large number graduate students I worked with, postdocs. It's been terrific. I've really enjoyed that. More than anything, that's what I enjoy. And I still enjoy it now.

And all these other activities that are visible when you look at my CV, I enjoy doing them too. But that's a secondary thing. And a lot of it I do as service. In part, I've said this to many people, but we haven't touched upon this in this interview, that when I started out my career, I thought I had no career. And the fact that I have had a career is because of society. So I feel that I should pay back for that. So I do all of these things for profession and people not in the profession, outside the profession; because I think it's the right thing to do. And I've gotten personal satisfaction from doing it. And the job at MIT allows you to do it. And MIT supports you for doing it. It's not a negative in your career here. It's a positive when you do good things for society.

Of course, if you don't do good things for science, it's not good. Your primary evaluation, I guess, must be in the science that you do and the teaching and the students. And that's always been my primary consideration. But this time and possibility to do these other things, as well, they come along. You know, I don't look for them. It's not my goal to look for them, but they pop along, and I try to fit them in.

INTERVIEWER: You describe some of the rewards of being at MIT as a faculty member. Are there particular events, moments in time, that were particularly rewarding or affirming or vindicating? Or is there a tradition that you participate in over and over that kind of reaffirmed your beliefs and the decisions you've made or the choices you've made? Whether it was defending a thesis or hooding ceremony? DRESSELHAUS: Well, thesis exams, not all of them elevate your intellectual level. But about half of them do. Some people really discover new things that are very exciting. And sometimes surprising. I don't know exactly how this works, but I think the students select the people on their committee to some degree. And I have quite a wide spectrum of thesis committees that I'm on. And there's so many very exciting theses that I consider that a plus in my experience here at MIT. Of course, I think my own students. I really like what they come up with for the most part. But, you know, I've had some role in that.

And speaking of students, I have made it a policy to take on, always, a couple of students who aren't making it and try to make something of them. I've suceeded in most cases. I think that's a role that we should all participate in up to the degree we can, because every person that shows up has some talents, and we should try to bring them out. Sometimes it's hard to find exactly where the talent areas are, but we should work on that. So I do those challenges as well. And some of that is hard work and not always as rewarding on the surface. But sometimes with an undergraduate that I've done that kind of work with, some years later, five, 10 years later I get a note from them. And I remember how hard it was working with them when they were here, when I really am very pleased to see what they've made of themselves. And they come back and thank me for what I did for them. I like that.

INTERVIEWER: Is it a matter of having them find their own direction or provided support?

DRESSELHAUS: Usually making a lot of suggestions that keep them from quitting and giving them some ideas about how to set priorities, how to organize their time, and how to deal with, cope with difficulties that they encounter, and so forth. And research is something similar to this. Those are some of the issues that you didn't raise, but it's not only the great ones. The great students we all enjoy. That's obvious. And we have so many of these brilliant people here that it's really great working with them. That's a great attraction of being at a university like this; the number of people like that you get a chance to work with. And faculty also, young faculty. Working with them is a great privilege.

INTERVIEWER: What would you say MIT's trajectory is? What is it evolving into, and if you could change its direction how would you change its direction?

DRESSELHAUS: Well, how is it evolving? I think one of the things that I see happening now, it's getting more international. MIT has associations with a lot of different countries and different programs. And maybe they're good. I haven't had much involvement with those formal programs, because I have my own independent activities. I think many of the senior faculty have international collaborations that go back many years, and we're always accepting students and going abroad and sending students, accepting students. And that's been a great resource for the development of the individuals. Having formal programs might be good. It remains to be seen, but I think that MIT shouldn't stretch itself too far. And we shouldn't have these formal programs take the place of the individual one-on-one relations which produce great research. Because for me, these interactions with people in other countries, you know, nowadays with Internet and what not, you can work with them as if they were around the corner. So of course, visiting them once a year is important; because there's nothing like a face-to-face contact now and then. But I think we should pay attention to leaving time for people to have time to do those kinds of things. And we'll see what the outcome of the formal ones might be. I'm not how they're going to work out, but they shouldn't take too much of our resources, intellectual resources.

INTERVIEWER: Maybe you can tell me a little bit about Rosalyn Yalow, to go all the way back to the beginning.

DRESSELHAUS: I actually haven't seen Rosalyn Yalow for the last couple of years. I wrote a short biography of her for a book. She had a lot of health problems. I don't know to what degree -- I suppose she likes to have some interaction, but she would like that I spend time writing to her, or I don't know about calling her. But I think communication would be through writing mostly nowadays.

INTERVIEWER: But the way that she influenced and encouraged you, would you replicate that with your students?

DRESSELHAUS: Oh yeah. Of course. Well she had a big influence on me when I was growing up, and what was so good about her is her giving to young people like myself when she was herself going through all kinds of difficulties, because it wasn't easy for her to establish her career. And the time she was interacting with me was the time that she was just beginning, even before, at the threshold of her starting. And then came the subsequent years when she was always there for advice or whatever, she popped out of the background. I never even asked for anything. She would always be there. And it was amazing that she did all of these things. I use her as a role model for my career.

Another person I use as a role model was Enrico Fermi. My interactions with him were of that nature, and everybody that I knew that knew him had a similar experience with him. So he died much too young and would have had a lot more influence on more people, but he certainly, in the short time that he lived, greatly influenced science and science education.

INTERVIEWER: How well did you get to know Fermi?

DRESSELHAUS: I knew him very well. I think that because the small number of students, the student-faculty ratio was kind of one-to-one in those days. You know, there were not so many students, and there were quite a few faculty. And he was a great teacher, and I had him for a class the first thing in the morning. And on my way, walking to school I would see him. And he would cross the street and walk with me. Who else would do anything like that? That's just being very friendly, and that made a long term impression on me.

The other thing that influenced me very strongly was his ability to work in every field of physics at one time or another in his career, often simultaneously; and the breath of his, as one person, being able to do forefront research in so many areas was astounding. I think that was another strong influence on me, and for most anybody else with whom he intersected.

We have a number of people here that knew him also on the faculty at MIT. I don't know how many of them you've interviewed so far.

INTERVIEWER: I think we're just about out of time.

Background Speaker: Can I ask one question? Given your unique role here at MIT, you came here with your husband and raised your family. Do you consider MIT part of your extended family?

DRESSELHAUS: Yeah, absolutely. MIT has always been my extended family. And my students are like my children. And we keep in touch with with so many of them. When something happens in their lives, they let me know.

It's not only my research students, but I'm always meeting students that had me in a class, and they remember me and they pop out of nowhere. I can't remember them all, because you know when you have a bunch of people in the class, you can't remember all the faces. And then after time, they look different. But they come around, and they recount the same things that I said about people that influenced me. And they're doing it back to me. I have changed roles over what we went through in this interview. But I think that from my own mentors or people who influenced me, they helped me to keep up the tradition. I would say that among women students, I've had more of an impact than on students generally. Because especially in the early days, and even for the men, I would be the only female faculty member that they would see in their entire taking courses at MIT. That happened to many, many students. So they remember me because of that.

Background Speaker: Kind of like a den mother?

DRESSELHAUS: Yeah. The Swedes once gave me a name on TV, The Queen of Carbon. I have a certain position, like in the field of carbon nanostructures. I'm the person at the end of the conference they call on, what did we learn at this conference? I give the summary talk. What did we learn? I guess you get certain roles that happen as a function of time. And as you do them a few times, and they get used to you, they want you to keep doing that.

Background Speaker: For you it's been a real family experience here?

DRESSELHAUS: It's not only that MIT has been a family experience, but my professional life has been a family experience. Because I don't only have this relation between the people that are here, but the people that are elsewhere. And I felt this particularly when I was serving in the government, and they would send me out on missions, sometimes to different countries. And any place I went, there were people who had me for class, or whatever. Any country. So I had my entourage already there. And well, the Department of Energy would make some arrangements for me to do this or do that, but my own informal group of people were much stronger. They could do much more for me to make my visit a success than anything that the Department of Energy could set up. And it wasn't the fault of the Department of Energy but was the benefit of science, that science is the universal language. And we know each other, and people care about other people.

So you know, now we're not so much loved in foreign countries, at least in the diplomatic sense. When you go, you hear about that. But on a personal level, it hasn't changed. MIT should benefit from that, because MIT is all about science and engineering and about this international win-win situation, because we've done so much for careers of many people, everywhere. And they appreciate that, so when we go to these places, they start with a positive note, not a negative note.

INTERVIEWER: One last question. Do you have a favorite hack, favorite prank that was played here at MIT?

DRESSELHAUS: Well, you know, I sit out there and look up there out of my window. So I look out at the tower over 77 Mass Ave. So when they put the cars, or whatever prank that goes up on the main dome, I see them. And I see them when they undo them. So the times that they put automobiles up there, I don't know how they do it, because they have a hard time taking them down. But those are the pranks that I actually see. And they're so funny, and so surprising. They cause a little trouble, but I think that we are willing to put up with creative student hacks.

INTERVIEWER: Thank you.