

INTERVIEWER: This is MIT's 150th anniversary celebration interview with Dr. Martha Gray. And if I can begin with the early years. Where were you born? Where did you grow up?

GRAY: I grew up and was born in the Boston area. I have to start over again. I've been here too long! So I was born and grew up in the Detroit area, and I was there actually until I went to college. I grew up with three sisters and a brother. A father who was an engineer and a mom who was a nurse. And had a, in some ways unremarkable, but wonderful upbringing. And family still lives in the same town.

INTERVIEWER: Do you remember, was there any moment in your childhood where you just knew you were going to be involved in the sciences?

GRAY: When I was growing up my whole view of what I thought my future would be were very typical I think of a girl of that era. I used to teach nursery school in high school, so I thought that I'd spend my career teaching nursery school or maybe elementary school. I was good at math, so they said maybe you should be a math teacher. And I don't know how I knew I was going to college. Maybe because both my parents are college educated. It didn't come up for discussion.

I knew I'd go to college, but I went to college thinking that I would be in Detroit or in Michigan at least for my life. And that's what I would do. And I'd be a teacher and do the regular things. I hadn't seriously considered science or engineering, any of that prior to going to college. College was really the place that my world view expanded remarkably.

INTERVIEWER: Can you tell me a little bit more about that and how you wound up at Michigan State?

GRAY: Thinking about how I went to college, I've thought about it a lot recently because my eldest has just left for college, a few days ago. And that whole process was very, very different for him than it was for me. I applied to two schools, Cornell and Michigan State. It's perhaps embarrassing to say that I chose those two because I had family in both those places. And they seemed like perfectly wonderful schools. Cornell costs probably still now 10 times what Michigan State cost. And so I went to Michigan State. Which was a wonderful choice but I wish I could tell you that I had thought about college in some strategic way. I'm not sure most people do. But that's how I came to be going to Michigan State.

INTERVIEWER: So how did your world view expand there?

GRAY: Well, one of the lucky things that happened at Michigan State for me was, number one I was part of a residential college. And so that meant that though there were some 40,000 students at Michigan State at the time, you were in a much smaller cohort where you got to know other students and faculty. And the college had a science, math, engineering type-- they didn't call it that, but it tended to emphasize that. And my world view opened for perhaps obvious reasons. One is that you meet people from all over the world. And their whole view of life is different than the one place I'd grown up. And secondly I had faculty who really reached out to me and perhaps others. And because of that, I wound up in computer science actually. Someone said, you're really good at this. You should consider it.

And at that point I had taken some math education classes thinking that that's what I was going to go do. And I knew I was capable of more than that. And computer science was a lot of fun. And then that's what I did. But I think I was fortunate in just meeting the right people. I'd say that's been true throughout my career. You meet people. They make you think about the world differently, and you do things you never anticipated beforehand. And that was true of my college experience.

INTERVIEWER: So when you graduated from Michigan State, how did the decision to come to MIT come about?

GRAY: I decided to come to MIT-- Backing up, the sequence of events that led me to come to MIT were completely random chance, serendipitous. And a month before I said I was coming to MIT, I never would have known it. So to back up and explain that a little bit further, I actually applied to MIT and to other graduate schools because I had a faculty mentor at Michigan State who said you really should go to graduate school. I wasn't seriously considering it, but if I have a faculty mentor telling me you ought to at least apply, the worst that can happen is I turn people down.

So I applied to MIT and other schools for computer science graduate school. And I also applied to industry. Completely coincidentally, somebody from MIT, Roger Mark, came to Michigan State. He came because his brother in law's best friend happened to be my professor. So we were introduced. And Roger Mark came to Michigan State to talk about the newly formed PhD program in HST, in Health Sciences and Technology. And so he talked to me and then he gave me a call about a month later, and said you've been admitted to MIT, but I think what you say you want to do, this would be perfect for you. And I can say more about what made it perfect, but that is the reason I came to MIT. Is that he happened to go to Michigan State, that he met me, and that he called to me after. And it was a perfect match for what I thought would be cool.

INTERVIEWER: And why was it a perfect match?

GRAY: So at this point I wasn't sure that I wanted to-- So backing up, since I didn't incorporate your question. I knew it was a perfect match. The suggestion that I join the HST PhD program, because at this point I was uncertain about a career as a pure computer scientist. That I wasn't sure that was a fit for me in the long haul even though I could do it. I had developed some interest in medical applications, both through research at Michigan State and elsewhere. And what really captured my imagination about HST was the idea you could do engineering or computer science in the context of medicine with applications to medicine. And you did it by working shoulder to shoulder, being in the same classroom with MD students. Being taught by engineers, being taught by physicians. And to me, as an absolutely gut reaction, I thought this is the way to do it. And I thought that was just the coolest academic idea I'd ever imagined. It was so different from anything I'd ever seen. And it just felt right. I was nervous that I couldn't survive MIT, but I thought that this was actually something. I had to give it a shot.

INTERVIEWER: So was that the origins of your interest in sort of the propagating collaboration?

GRAY: So the excitement that I had when I first made the decision to come to HST has actually only grown. And I will tell you today that it is absolutely the best professional decision I've ever made in my life, to come to HST. For the same reasons it was exciting to me then. It's what I've continued to spend a lot of my time doing. Helping other institutions, governments, do the same kind of thing, because it remains a very unusual kind of experience. So in fact, in my old age-- we're talking about the early years now-- but in my old age, I think one of the most important things I can do is help provide those kinds of opportunities for many, many more people than can get them now.

INTERVIEWER: Is it the nature of collaboration itself? Or is there something about HST that is unique in your thinking?

GRAY: So I've thought a lot about what makes HST tick. Is it my interpretation of the opportunity? And is that just a quirkiness that I have? Or is there something fundamental about the way it is structured? And after nearly 30 years in participating in it, I actually think there is something quite fundamental about how HST is structured and implemented. And the thing to compare it to is most of academics, virtually all of academics, from an educational point of view is disciplinary focused. The job of departments and department heads is to steward the discipline. And over 400 years, these disciplines have become narrower and narrower and narrower, as the knowledge base has expanded extraordinarily. And that's a very, very powerful paradigm that has led to a huge number of advancements.

But it's a very different paradigm when you think about where do you go with what you know? And how do you do the next step? Than saying we're going to think about major problems. None of which are solved by single disciplines or professions or institutions or individuals for that matter. And it doesn't happen by accident. When people are able to connect with other disciplines and professions and people. It's partly a phenotype, it's probably how people tick. But also I think, just as you can educate people in a disciplinary way of thinking, you can educate people to operate in a multidisciplinary world. So the magic of HST fundamentally is that you have to become comfortable with multiple disciplines and professions.

The people that are attracted to it-- like me --I think are instinctively drawn to those kinds of opportunities. And less drawn to disciplinary opportunities. But I think the experience of having to work side by side, teach classes with a range of disciplines, helps you build the experience base that enables you to trust and value other disciplines. To have an expertise yourself and understand how to reach out. It becomes hard to articulate in any sensible detail in general terms what happens. But there is a certain magic that is not replaced by content in a classroom, or by a single professor. It's a community thing. It's a value system thing.

INTERVIEWER: Is it the nature of the problems that you're working on that requires more interdisciplinary background?

GRAY: I don't think it's that. I think there are huge problems. I've focused most of my career, all of my career, on medically related problems. But I think when you think about the environment and energy and economies probably, there are many, many really important problems that are not purely disciplinary. And it's easy to interpret some of what I'm saying in a way I don't intend. So I'm not saying that there's no value in disciplinary work at all. In point of fact, people who do multidisciplinary things like I do, can't do it in the absence of a very strong disciplinary setting. Even though my approach is different, at some level in our education and what I do, I count on the disciplines continuing to grow and flourish and develop and subdivide and so forth.

Secondly, people who work in disciplinary work certainly work on important problems. So I don't want to say and I don't at all mean that if you solve important problems, you do it in a multidisciplinary sense, and all the rest do disciplinary. What I've really come to believe is that we need to create an academic culture that supports both those paradigms on equal footing. That we really need both. Not turn all the disciplinary people into multidisciplinary people. And certainly not vice versa. But we need to create that. And I think people feel much more comfortable in one versus the other.

Many people who are multidisciplinary have multidisciplinary instincts, function effectively in a disciplinary setting. But you have to ask whether or not they would be even more impactful if they had a multidisciplinary work. I mean, lots and lots of smart people who do work in spite of whatever barriers there are. And there are always barriers.

INTERVIEWER: Well it may not be quite as important if you're a specialist in poetry.

GRAY: Yeah, I guess it may be true that if you get out of the sciences and engineering and things like that, that what I'm saying is less true. But I bet if I were an expert in other areas, that I think this is a general. There are different ways of thinking. I have colleagues who are anthropologists for example. You mentioned poetry, and I won't. I don't know. And the arts tend to be more individual sometimes. But anthropology I think struggles with this issue as much as scientists do.

INTERVIEWER: So if we can go back to the sort of sequential. When you first got to MIT, can you talk a little bit about your first impressions? Maybe how it was different than Michigan State.

GRAY: So at this point, it's hard to recall with great fidelity, and any certainty of accuracy, how I felt when I first arrived. But what immediately jumps to mind when I think of those early years. One is that MIT is much smaller in terms of numbers than Michigan State. But in many ways it felt much bigger. And I don't know if some of that is just, you walk into a completely new territory. And by then I was quite comfortable at Michigan State, because I really have very few memories of what it felt like to leave for college. But it may also have been a part of, this is a world of fiercely independent people. Everybody's trying to head somewhere. And I say that in a positive sense. And I come from the Midwest, which does have a certain social, friendly culture, that's outward. People here at MIT are very friendly. But when I travel back to the Midwest, there's no question that there's a somewhat different general feel to that.

MIT's an incredibly exciting place to show up. I do remember feeling like I was handed, you can do what you want. Just figure it out. Which was part of what attracted me to here. But it's also a major change from undergraduate school. I think that's a general comment about undergrad versus grad school as well.

INTERVIEWER: So talk a little bit about your graduate experience for your Master's and doctorate. And how that sort of educational process felt different or seemed new to you.

GRAY: Well, when you think about comparing undergraduate to graduate experiences independent of institutions, an undergraduate experience is largely driven by satisfying requirements that are laid out for you. There are some electives and the degree towards certain electives depend on the institution and the area. But there's still a set number of credits or specific courses you have to take. So your road map is not entirely open. Graduate school, the explicit road map is mostly, you have to pass your qualifying exams. And you have to do a PhD thesis. Then there are a few course requirements there. And I'm exaggerating the differences some, but not a whole lot. And so in a way that I personally hadn't really thought through is, okay, what do I really want to do? Where do I really want to work? And how do I find this out? And that's just not something I remember worrying about as an undergrad. Now that could be me. And I was growing. And it could be that it's a general case. But I think when I see even undergraduate students at MIT becoming graduate students at MIT now, this is a big transition. And those two ways of thinking.

In my graduate work thought at MIT, I was very fortunate to be part of a small group of people that started the same PhD program. We were the first students in this HST PhD program. At that time, Building 20 still existed, so we all had this big office space. You know, it's just a big space with desks. So the camaraderie that developed through that, even though we all took very different classes, at least our classes outside of the HST classes, we had developed very, very close friendships. Ones that I have to this day. So in that sense, I think my graduate experience was incredibly positive, compared with what some people I know still struggle with, where getting to know people becomes more difficult.

INTERVIEWER: So when you finished your doctorate, how did you wind up deciding to do the postdoc work? And can you talk a little bit about that?

GRAY: Well I'd say at the end of my time as a graduate student, I hope it's not heresy to say this, but I told many people I'm never coming back to MIT. This has been a wonderful 10 years, but now it's time for life. Right? And I hadn't thought a lot about exactly what I wanted to do next. I considered for the first time in my life whether I should get an MD, because I had done a lot of clinical work at that point. Considered academia, maybe partly burnt out. And somebody I knew offered me a postdoc, and it seemed really interesting. It was going from med school to a vet school. And I thought they were many fascinating things about that work. So I thought that was a logical next step. Again not a whole lot of planning any more than my plan to go to undergrad or grad school.

In the end, when I was doing my postdoc and a faculty position became open here in HST, and then I got the offer. I said forget it, I'm not going to do an MD. I still think HST is just the best thing ever. And I have many colleagues here that, again wonderful mentors, who encouraged me along the way.

INTERVIEWER: Do you want to mention some of them?

GRAY: Let me come back to that. Let me think about how to do that.

INTERVIEWER: So you didn't have to be away for very long before you decided it wasn't so bad here after all?

GRAY: It is true. I didn't have to be away that long to decide. The separation didn't make me say my concerns about MIT life were groundless. But the real point is where are the opportunities? And so I think timing is often an important issue. So the timing was fortunate, both in the decision to come back. There was the possibility of a faculty position, which isn't always the case. And secondly, the laboratory of my postdoc moved from Grafton, Massachusetts to the middle of Long Island. And so I had to be uprooted one way or the other. And so it became a fork in the road in determining what to do. And the timing plus the enormous opportunity. I thought, it's worth a try. I don't know if I can succeed at this. But I truly believe it in my heart. And I was duly appointed in HST and electrical engineering. And I'd very much liked my colleagues in electrical engineering and computer science. So again, you reach the fork, not because I planned it so much as it seemed like the right decision to make at the time.

INTERVIEWER: I'm wondering if you can articulate the difference, how it was different being at MIT as a faculty member, where your previous experience had been as a graduate student.

GRAY: So we've been talking about a number of the transitions as I've moved from one position or institution to another. And the move from being a graduate student to faculty member is as large as undergraduate to graduate. And the fact that I came back to the same place adds a whole other layer of complexity. The obvious layer of complexity is that I was here as a student. People knew me as a student. You become a faculty. To some people I'm still that student. It's not explicit, but there is that, and the expectations and the mode of interaction stays the same. I wouldn't say that to my knowledge that was problematic. Most of it is how do you engage with people?

What I remember even more than that is that the students here, however, know it's a big difference. I went from being one of them to the other. And so whereas before, I was an addition to our many scientific discussions, which continued. The whole social infrastructure was dramatically different. I no longer was part of that social culture of people that I had known well even a year ago. So that transition was more stark because I had been at this institution and they were people that I knew.

The other differences between being a graduate student and faculty are probably completely obvious. You go from it's up to me to decide exactly what I'm going to do in research. To some extent I had done that as a graduate student, but you have a different layer of protection. You had to teach. And I hadn't really done any teaching before. So as this place is, it's the fire hose. And that fire hose exists at every single level I think, including becoming a faculty.

INTERVIEWER: I'm a little uncertain how to address your various areas of interest. So maybe the best way is, can you walk me through your career here, and how your areas of expertise have connected over time? If they have?

GRAY: You think they've connected?

INTERVIEWER: Well maybe they don't.

GRAY: You know, if I think about what I've done and my career at MIT, there are really sort of two buckets. And they are to some extent independent. So the one research bucket has been my work in arthritis. Where I've had a longstanding interest in understanding how connective tissues that line your joints, like your knees and hips, what makes them degenerate? What makes them grow? Do they repair? Those kinds of questions. And in particular, whether or not mechanical forces like as might happen, certain forms of injury or forms of exercise or your personal anatomy, what role those mechanical forces play in the development of your tissue and your risk for having degenerative arthritic disease. That area of interest actually got me into cartilage imaging. So those are directly linked. And I got into cartilage imaging largely because it was clear that the tools we had at our disposal to understand how they adapted to mechanical forces just weren't what they needed to be. Especially trying to understand what happens in real people. So I have no idea what, nobody knows what your cartilage looks like, and whether or not it's in good shape or not in good shape. And in order to actually address the medical problem, you have to actually assess whether you have it or not at some early stage.

INTERVIEWER: So before the imaging, the only way to know anything would be to open up someone's knee, for example, and look?

GRAY: So there's two contexts in which I've been interested in understanding how cartilage degeneration might occur. So in the medical context, which is fundamentally what we care about addressing, even today the way in which a clinician determines whether your joint is in good shape is x-ray. And you can't see cartilage in x-ray, but if the bones are touching one another, you can presume there is no cartilage between them or if they're very close. You can also, if you happen to have an arthroscopic exam, where they put a light into your joint and then you can look directly through that. And the other is complaints of pain. So if it really hurts, the presumption is that you have some tissue distraction. Not always the case. You have to rule out other things. So today, that's the gold standard clinically. And that was the gold standard 50 years ago. There's been some advances that allow you to look at cartilage directly and measure its morphology. But so far those have not really turned out to be any more sensitive to early prediction of disease or degeneration. So you can tell when somebody has a joint nearly destroyed. An underlying assumption, all that I'm saying is that if we want to prevent it or understand it, we need to look much, much earlier than the point at which you've lost the tissue from the joint. At that point the likelihood of repairing it short of total joint replacement, I think and most people would agree that it becomes much, much longer.

The kinds of studies I was doing initially were not clinically based. They were ex-vivo. So that meant we took pieces of cartilage out of animals. Typically you can do it with human tissue. And keeping it alive. In an incubator in the right kinds of conditions. And then we would apply mechanical forces and look and see what the cells did differently as a result of that. And there's been lots of work of my own and many other people in the last 30 years looking at that question. The real challenge to that scientific approach is that the time scale over which changes happen, that we care about, are weeks to months. And it becomes technically very, very challenging for reasons I can go into if you're interested. But it becomes very challenging to think about keeping tissue alive and understanding from that what happens in response to mechanical forces. Unless you can visualize it in a non-destructive way. So if I can take a picture of what the state of it is today. And then tomorrow, and next week, and the week after. Then I have a chance. But if I have to destroy it in order to measure it, then you have to have hundreds of samples. And it's just technically very hard. So it's those two sides that got me interested in imaging.

And we've talked again a lot about transitions and how we make decisions on what to do. So it wasn't that I sat in my office one day, frustrated about the difficulties I was having in doing the kinds of experiments, as frustrated as I was. But it was really an encounter with a colleague where I learned what you could do with imaging. This was a colleague also had been an HST student with me who did cardiac imaging. And the techniques that she was using, I thought, oh if I could do that in cartilage, that would change the world. That would be very, very different. And so then we got together and convinced people eventually to fund us. And that really started what we thought would be a five year project, which is now 15 plus. Maybe almost 20 years.

INTERVIEWER: You mentioned that your areas of interest fall into two buckets. So what's the second bucket?

GRAY: Okay. So the second area of interest is not research per se, but it is academic organization. And trying to create academic ecosystems that support and promote multidisciplinary kinds of approaches, not just for research but in education. And to do that with the backdrop of disciplinary institutions. So my 13 plus years of leadership in HST certainly got me thinking about that. About how do you create organizational structures that really can enhance and enable that? And through as an HST director, I encountered lots of people that were thinking about the same things elsewhere. And was increasingly called to advise and even help create similar kinds of organizations. And again, it wasn't that I had this laid out plan when I started HST. I thought I would be running HST for six months. But as I became part of it, I really began to understand how it really worked, and why I think the issues are foundational. And so forth. And I also saw how difficult it is to make it happen, even though for me, this was motherhood and apple pie. And I couldn't imagine why everybody didn't try to make this happen. And I also didn't understand until trying to understand disciplinary structures better, why it was hard. So as I became to understand that, I realized that this actually is. I don't know if it's so much an area of study, but an area of potential impact.

INTERVIEWER: Tell me why it's so difficult.

GRAY: It's reasonable to ask, what is it that makes it so hard to create an academic entity that is multidisciplinary in the way I think? And it has a lot to do with the culture that gets embedded in organizational structures. So with 400 years of development, or however long it's been, the disciplinary approach has really emphasized the individual. It's emphasized your contribution to that discipline. Even if you worked with others, the question that gets asked in promotion is, what was your contribution out of the 10 other people? There's some notable exceptions to this broad generalization, but everything about how we think about who do admit as students, what to support in terms of who we hire as faculty, how we evaluate faculty, all of those things are really framed in a disciplinary context. In fairness, I think everybody at MIT and many other places say, we love multidisciplinary interdisciplinary research.

So it's not that people don't acknowledge or believe that working together in collaboration is important. But nine times out of 10, these multidisciplinary collaborations are a division of labor. Which is not the same thing as saying we are in it together. At the risk of putting a terrible-- it's like marriage. You can't be both the man and the woman in a heterosexual marriage. But you better begin to trust and understand to the best of your ability. And it is never perfect. What that other is. To work together, to do whatever you do. So it's that kind of thing. And the evaluative structures, the hiring structures, what you implicitly value. Not what you write on paper. What you implicitly value is fundamentally different between a disciplinary organizational and multidisciplinary. And I don't think you can make people who think in disciplinary terms magically become the people that make the multidisciplinary happen. I don't actually think one organizational unit can do both of those things. Another thing I've thought about quite a bit. That they really are valuing two different things.

Related to that, that's part of at least in the medical context. Many of the people you want under the tent for a medically multidisciplinary approach are people that are not necessarily even part of your own institution. So it mattered to us that we had physicians. Even practicing clinicians that aren't necessarily scientists. MIT is very strong, because people value the quality of the science and the engineering that happens here. That is its bread and butter. At some level, its bread and butter claim to fame. Clinicians, as innovative as they can be, they're not innovative in that same way. So it's very hard in an Institution that's built on supporting that one thing, to legitimately value the other guys. As the head of HST, I'm in a very different position. So there, I can say, it's my role to value it. And it's part of our strategy. It's part of our-- But I have to do that in the context of recognizing that the head of biology may feel very differently about the value. As he should.

INTERVIEWER: Do you think it's-- It's not either or I guess. Is it a lack of experience in the way people have been educated? Because it is sort of getting narrower and narrower as you get further in the academic process? Or does it become an issue of ego?

GRAY: I think there are a lot of reasons that in addition make it difficult to move to this being the norm. In some ways one of the biggest is that there are not many examples of an HST-like structure. There are many examples of research institutes that include multiple disciplines. But they tend to be either structured differently, or the promotion of the individuals is related to their discipline. But there really are not very many-- if any --other academic organizations to cut across. So I think it's hard in the context of academia, where a lot of what you do is compare your value to somebody else's. How do we compare HST to something else? In biology or electrical engineering, or pick any department here, some of the way they measure success is comparing themselves to other biology departments. There's some implicit, not explicit, but implicit understanding of what it means to be that unit. It just is embodied in the individuals here. But there's no implicit worldwide or nationwide view of what that means. And I think that probably is the single biggest challenge.

It's not the most important reason, but is one reason why I've gotten involved in talking with other organizations about how to do it. I think if there were more around the world, it would strengthen MIT in this space. MIT's been a leader by having HST formed in 1970. It's remarkable. That was definitely a vision for the future. And it should be recognized for that leadership role. But it would be even more recognized if there were others around. So a form of criticism for example is, if it's so great, why hasn't Stanford done it, or why hasn't-- Which is I think is an understandable statement. But I think the reason they haven't done it is it's really hard to do, unless you think through what it means to create that kind of position.

INTERVIEWER: So as director of HST, you transformed the organization pretty significantly. Can you talk about how it was when you first started as a faculty member? And then how you moved it into a model that you think works better, promotes interdisciplinary work in a better way?

GRAY: So, when I took over as director of HST, we thought a lot about how do we strengthen HST? Every organization can always be strengthened. How do we strengthen HST so that it'll still exist 50 years from now. What are the things that need to happen? And when I started HST, some of the key players were ones that had been part of HST from day one. So these are people that were my teachers when I was there. And obviously that isn't going to last in perpetuity. There were a couple key areas that we addressed. One is that HST was mostly defined by the students. It had some 300 odd students at the time. But it was created mainly by borrowing faculty from other departments. And I think it attracted those faculty for reasons that varied over the years, but partly because they were unusual faculty in their own departments for their interest in medicine. So in 1970, there weren't very many people. It was unusual to be interested in health and medicine. Nowadays MIT is a transformed place itself, in terms of the emphasis on health and medicine. So we needed to evolve with that in that way. So I don't think that any academic organization is sustainable if you do it by borrowing faculty from others. And for reasons that are I think both obviously and completely understandable, you need a few changes in department heads when you have conflict between the time demands on faculty that are nominally part of one department and we're borrowing them for another, for example. And that's completely appropriate for them to have concerns. And it makes it impossible for somebody running HST.

So one was to build a faculty. In terms of building the faculty in a way that supported the objectives. It was clear that building a faculty that were made up of people that were only appointed in HST would only serve to create something that was not multidisciplinary, because you can't possibly cover all disciplines and professions in one unit. So we spent a lot of time with people who were principles at HST at the time, thinking about how do we build a faculty structure that actually values people who may be appointed in another department, and actually to the extent possible pays them for their time? So that we could have a multidisciplinary kind of faculty.

So one of the big changes in HST between when I started and when I finished was when I began there were five people with primary appointments in HST. Most of whom have been there for a long time. And there were about 200 affiliated faculty who had no real explicit role. To a very, very different structure including the end processes to support the structure, that had a faculty that included primary and dual, meaning they were appointed in two departments and joined, which is a complicated version. Of course Harvard and MIT have different names for these things. But that was our faculty. And they were evaluated. They were evaluated by committee, they were evaluated up the line at each institution. So they were legitimized-- if that's a word --in their role. And you can't have faculty meetings with five. You can't run an organization with 300 students and five faculty. You need real faculty. So we moved to a faculty of and about sixty in that way. Including hiring about 13 new people. And maintained affiliated faculty to do some things like our clinical teaching.

So we changed both structurally and in terms of the people that were there, the average age dropped by probably-- I didn't figure it out, but it had to have dropped by at least 30 years. And that of course brings important and positive energy into the organization. So the faculty was probably the biggest change that I think I made as part of HST. Everything else in some ways followed from that. You don't do anything without faculty and colleagues. So I could tell you I did it. But really I was part of a big team of absolutely amazing people that believed just much as I do in the value of this kind of organization, that made it happen.

INTERVIEWER: So it sounds to me that what you're talking about in terms of creating an environment that supports true multidisciplinary problem solving, has to do with money. In that if you have sort of affiliation with an organization, but you're not really paid by that organization, most of your efforts are not going to go in that direction. But if you're part of the organization and paid by that organization, and acknowledged for your value to it, then your commitment would be greater, the time spent would be greater, and all of that?

GRAY: So I did mention that when people are part of the organization, we wanted to pay them for it. It is not completely to say that it's all about money. That paying somebody for that role is all that it takes. So it is about money to the extent that there's an expectation that people are supported for the work they do, which includes the salary. And there's also a recognition that if somebody splits their time with multiple loyalties, that if somebody else is paying their full salary and we don't have some other kind of arrangement, that that's a setup for a challenge down the line. It may work out initially because there's some common values. So money is a piece of it. But just as important as the money was the process and the way in which-- The process for appointment which involved a conversation.

The people that were part of HST primarily, it's straightforward. It's what you would expect in any department. So the trickiest people are ones that are appointed primarily in another department. So the process through which they were appointed, if they were already here, involved conversation with their department head. It involved often shared things that led to that department benefiting through HST's effort, just as it benefited HST. So those kinds of conversations took place. And in some cases, it involved us supporting part of their salary. So partnerships work because they're valued by both parties. So they had to work at the faculty level, but they had to work at the organizational level as well. The value that came to me as head of HST, or came to HST, might not have been identical to the value that went to the other unit. But it was as much my job to make sure the other unit felt valued, as it was that other unit's job to see that we got value. So the fundamental premise is what makes partnerships work. Which is absolutely more than money.

INTERVIEWER: So there is some ego involved?

GRAY: There is absolutely. There is ego involved, and we were helped tremendously by the vision of HST. People in other units very often, really wanted this kind of academic community in order to thrive. They felt this is how they thrived. They thrive because they have students like this, because they're next to colleagues that they otherwise wouldn't be on committees with and meet. Especially young people. Once you get old, you also know a lot of people and the organizational structures don't matter as much, in terms of your networking. But when you're young, that's actually a primary way in which you end up meeting people and going in new directions. So we provided a very different kind of academic community to faculty who were part of disciplinary units. So if we'd handed somebody money who actually didn't value that, they would have taken the money maybe, but it wouldn't have valued us at all. So to some extent, ego has to be a part of it. But that's not the first word that comes to my mind. It's how do we enable somebody who really values this. And then create expectations that say they have to help make it happen as well.

INTERVIEWER: If we go back to the two buckets. The research in arthritis and in imaging techniques. And then this sort of, how do you set up a truly multidisciplinary research facility. Can you tell me as you look at those two areas, what accomplishments you feel the best about?

GRAY: Now if I think about the accomplishments I feel the best about, I'm not trying to articulate them in the context of the two buckets per se. So I feel the best in many ways about people. So I'm very, very proud of all the faculty that we recruited from outside this Institution. Who I think are wonderful assets. What little role I can play in helping them launch their career and then have their impact, I feel very, very good about that. And same way for the students that I've had in my group, which would be younger colleagues that I've worked with in my group, that have been able to do things. So in some ways the most important thing we do in terms of impact has been the people. And the faculty told me that when I was a student, and I didn't believe it. I mean, it sounded gratuitous and now I find myself, at the end of the day, where do you say, I feel really good about what I did. And that's it. There were probably 100 different strategies that could have led to that same outcome. And I picked one or two or whatever. But that's actually far and away what I feel best about.

INTERVIEWER: I wonder if you would talk just a little bit about some of the programs that were created while you were director of HST, like the biomedical enterprise program?

GRAY: So, I said before that the number one thing that I worked on in HST was building faculty. But we did build a number of programs as well. And in some ways, one of the most interesting was the biomedical enterprise program. And a thumbnail sketch of that program is to bring in individuals who are interested in having an impact in health and medical sciences, but to do it through enterprise. Through big business, small business. And the underlying premise is that traditional training for these students, say an MBA, tended not to include the many unique things that are associated with developing a biomedical device or drug or biological of some sort. Number one. And both in regulatory terms, but also in terms of the ultimate recipient of that advance-- whether direct or indirect --that is to say the patient.

So this is a program that was actually modeled on the PhD program. It brought in people with a business interest, as I said, but put them in the same classroom with our graduate students and our medical students. It gave them an opportunity to interact with patients, which by the way I don't believe I mentioned that on the PhD program, the second thing that was the clincher is that as a PhD student I had to take care of patient. And there's no better way to understand what that experience is really like, than to go in and do it. Not because you want to be a clinician. But if you want to understand the real world as it were. And that being there, no classroom can replace that. Similarly for these business students, we said, if you want to understand the way in which clinicians make decisions, the way in which patients make decisions, how that whole encounter is structured, you've got to go there and you have to see it. So they had a designed experience at Mass General where they did that. So this attracted a very interesting and spectacular group of students. If they didn't already have an MBA, they received an MBA at Sloan. And a Master's from HST as a dual degree.

It was an experiment in saying, can we take the model of the PhD program, apply it to a somewhat different paradigm, and come up with a curriculum. There are many, many things I would continue to improve about the curriculum. But the fundamental structure I think has proven to be very sound. So I've told you why we created BEP-- our acronym for biomedical enterprise program --for the students and for the world. From an internal point of view for HST, a lot of the reasons people want to be part of HST is they want to solve problems in human health. In order to solve many problems in human health, they have to be translated. They need to connect eventually through some business enterprise. And even though I personally felt that was a perfectly legitimate career path for a PhD and our MD students to take, they had really no exposure and certainly no exposure through HST to people that thought about how to do that. So by creating BEP and putting it under the umbrella of HST, it created a sense that we valued that as much as we valued becoming a clinician or becoming a bench scientist. And I had MD students and PhD students use phrases like, I felt like now I could come out of the closet, because I was really interested in taking what I'm working on and carrying it through.

So companies have formed between PhD students and our BEP students and the conversation has changed, and the faculty enjoy having a whole different kind of questions come up in the classroom. One of the most powerful things actually in the classroom about putting these multiple disciplinary students together, is they really learn more from each other. Not necessarily content, but they learn the values through the questions that are asked. So business students ask different types of questions on average than a science student. So that was a major program. And in putting it together, we engaged people from the local business community. They teach some of the classes. They were actively involved in the many discussions we had about how to create the program. Something that is also very unusual in academic circles. There's usually a pretty big divide between the business sector and the academic sector, except in the sort of boutique kinds of courses. But they were part of the process from the beginning. And I think that helped make it work.

INTERVIEWER: What I'm hearing from HST is you can show the value of the approach from the students that you attract and from the outcomes that happened. And so it sounds to me that if Stanford hasn't done it, it's not because it's not successful. It's because of the difficulty.

GRAY: Yeah, so there are many ways to illustrate the value of this approach. The students that are attracted are spectacular. And that's become widely acknowledged. And they've gone on and done amazing things. And in some cases transformed medicine. So I think when people consider whether or not they can do it, it's not that they don't look at this and say, we would love to see this happen. It's a combination of being unwilling to go the full way of saying, let's put all these disciplines in one place. They'll say let's create our MD program like HST. Or let's create our PhD program like HST. Completely missing the key point that really what makes it work is putting them in the same classroom. It's not the teachers alone or the curriculum alone.

And the second is creating a cultural infrastructure that fully supports it. It just requires an incredible tenacity.

INTERVIEWER: And it must still be evolving?

GRAY: Oh yeah, totally. I often get asked, what areas do you work on? How do you define what HSC should be? What research areas should they do? Because we're not building a specific research center. We're creating a community. At the same time, you have to be able to point to things and say, what are you doing? And with our faculty distributed. So one of the ways in which we have evolved institutions is creating these things are called *research nuclei*. And those are now in existence about five or six years. And so this meant creating a critical mass of people at specific locations. Like imaging was primarily located at Mass General Hospital under the Martinez Center, which was enabled by a big gift. But coupled to that the structure, the concept of a nucleus. So everybody there felt like they're part of HST. At least part of an HST center. So I think those kinds of strategies carried out gives some opportunities for other people to emulate. And maybe with that, may have an easier time making it happen.

INTERVIEWER: And how about the creation of the mentoring program, BioMatrix?

GRAY: Another really fun program that we created I've forgotten how many years ago now. We called BioMatrix. One of my colleagues was the creator of that name. And I was interested for a couple reasons. Number one: HST is a graduate student only organization. We don't have any undergrads. And so being involved in the undergraduate experiences is an important part I think of our responsibility at MIT. The solution for HST, I don't think is or certainly was, to create an undergraduate degree program.

On the other hand, one thing HST can do partly because it didn't have any undergraduate program is say, there are 100 ways you can have an impact on medicine. You could do it through biology, you could do it through electrical engineering, you could do it through chemical engineering. You could do it through whatever undergraduate training you want. And so what we really sought to do was to create a community for undergraduates in which their horizons were expanded. So they didn't feel that in order to impact medicine, they had to become an MD, or they had to do one department to another. That really they should follow their path, and there are just examples upon examples of virtually any path you could imagine. So it was set up to try to do that. And it wasn't specifically about creating people who were MDs. There are many MD organizations for that. Or about bioengineering. There's organizations for that. So it was a lot of fun.

INTERVIEWER: I wonder, the classroom environment when you have multidisciplinary students. How is it different than a classroom where you've got all biology majors?

GRAY: You know, one question I get asked often is, how do you actually teach students if they come from all of these backgrounds? In a class on human molecular biology and genetics, we've got people in the class, some of whom are pursuing a PhD in molecular biology. And then we have a mechanical engineer, who presumably does not have the comparable background in that. Let me say three things about what we have to do in terms of supporting that kind of course. One is, we felt adamantly that you still want those same people in the room. If you start dividing people up by what they know previously, and creating molecular biology for dummies, and molecular biology for those with experience, you've erased the real value of putting these communities together. It requires that the faculty who are teaching the courses be absolutely comfortable with the fact that they've got this broad range of expertise. And find creative ways to use it.

It also means that you have to place expectations on the students that may not be as up to speed. That they better find a way to learn it. They're about to become professionals. They're not going to learn everything through a course. They've got to find it. They have to be expected to find ways to figure it out. And maybe the more senior students help. There are various approaches that are put in place. It works because the people that know the most are not the same people as they go through the curriculum. So those people that may be struggling to catch up in one area, are the ones that actually are the authorities in another area. So if the faculty doesn't try to teach to the lowest common denominator. And that is a disaster for everybody. If they just take that, then it works from that standpoint.

The payoff tends to be that the nature of the discussion in these classrooms is unlike in a very narrowly defined classroom. The classic story about the person who knows nothing asking a penetrating question out of complete naivety, that does happen. So faculty will come in and give guest lectures, and they'll say that was one of the most interesting lectures I've ever given. I got better questions than I get when I go to a scientific meeting. And I know that some of the students asking them sort of feel sheepish, because I'm sure this answer's obvious and I'm an idiot, but can you just help me understand this? And part of that is where people develop the trust and the comfort in living in that environment. So it's surprising how many things we think are absolutely known, that are actually not necessarily really known. They're just part of our current framework.

INTERVIEWER: So, can you fold this all into a discussion about the VaNTH Engineering Center?

GRAY: VaNTH is too boring. It's so long ago now.

INTERVIEWER: Or maybe just what's happened. How it's developed in the last 10 years?

GRAY: So very early in my time as head of HST, we got involved with a number of institutions led by Vanderbilt in a project called VaNTH, which is the acronym for all the institutions. But it was an engineering research center on educational technologies for biomedical engineering. So that long winded title, the real goal was to see if we could develop advanced educational tools that could be used in a classroom in medical school or bioengineering, to make it easier to teach the concepts that were fundamental to say physiology, or other areas that are relevant to bioengineering. So we talked earlier about how do you deal with a very diverse population in the classroom? And one of the realities is that you don't want everybody to know everything in gory detail. What you really want in a classroom is to help them develop a framework and a set of intuitions about how things are. That if they really need to know-- whether you're the expert or not --if you get to the point where you have to go into fine detail, you actually start exploring it yourself. What you can do in a classroom is help to get the instincts right.

So educational technology is one way in which you have a chance to allow people to develop those instincts. So we tend in real life to develop those instincts by playing with things, by building things and seeing them fall apart. By various forms of hands on or non hands on experimentation. So with educational technology, if you set it up right, you should be able to create these safe environment simulations, for example that allow students to play with different parameters of a model. Or of how the kidney works for example. And get intuition. And those kinds of things happen all the time. We've had them in HST from the beginning. But the problem is they're built by one individual. And as soon as that person retires, or the equipment breaks or something like that, you're back to square one. So doing it in a way that makes it as much a part of the educational experience as a textbook would be, or as a web course these days would be, was the vision of VaNTH. Can we bring people together to understand how people learn? So it was also a multidisciplinary group. How people learn? What educational technology tools are there? What's the domain expertise? Putting them all in the same room, with the goal of creating sustainable infrastructure and sustainable tools that provide that intuition.

So the project itself was eight years. It's a 30 year project. So it's worked on in bits and pieces since the NSF mandated an eight year drop dead time. So we all still work on it and we all still communicate, and there have been some wonderful advances to our classes. But it's a long way before you can say, I can point to this artifact and say, we've gotten there. So that's a work in progress still.

INTERVIEWER: I guess in some ways I think that you're sort of uniquely situated. Because so much of your thinking about teaching has changed from when you started to the way you approach it now. And I wonder if you could talk about how that's changed. And how would you describe what you think is really good teaching now?

GRAY: So you're asking about teaching per se, not education generally?

INTERVIEWER: I'm not thinking about them being all that separate. The changes that you've made in terms of how you approach the classroom environment, and why you've made those changes?

GRAY: One of the things that the VaNTH project in particular taught me, and really opened my eyes was to a huge body of work about how people learn, that had been developed primarily for the K through 12 group of students, but that I think is equally relevant to anybody learning it at any age. And in retrospect and even at the time, the specifics that we learned are very intuitive. One is that we learn through mistakes. I should say, mistakes appropriately managed. There's a huge difference between what a professor thinks they teach, and what students learn, if you're not careful. So teaching is not equivalent to learning. And third is that teachers can learn a lot about what their students learn from their misconceptions. Not from the right answers, but from when you see what wrong answers they come up with, and how did they do it?

What's changed I think most in my own personal teaching is, that learning experience happening at the final exam isn't useful to me or to the students. It's much better if on an ongoing basis, in the classroom, I or whoever sets up mechanisms to understand where the students are at any point. There are lots of strategies to do that. Because what you learn is when you see the mistakes they make, then that influences what you then teach. So to a degree, it never would have occurred to me as a starting faculty where I did lectures like everybody else. Whether I'm teaching electrical engineering students or medical students, I'll often put problems and then ask them to write it on a piece of paper. And they have fancy electronic versions of this. And use that as the basis for deciding what I do next. And it requires some flexibility, because sometimes people are way more confused than I could have imagined. I have to sometimes come back and say, I'm going to teach this again, but I've got to think about it. And I'll teach it next time. But clearly I think that process of finding ways to reveal where your student actually are, and addressing it at that level. Again, very intuitive, but not the way I thought about teaching when I started with the faculty.

INTERVIEWER: The difference between top down and bottom up.

GRAY: Yeah. I mean, you still have to provide some top down structure in terms of the kinds of things you're expecting them to know. But again what I might lecture on, you hope it has a relationship to what they learn. But it doesn't necessarily. And it's surprising, and it shouldn't have been surprising, but I'm always surprised when I see it. Is how much people who get the right answer learn from seeing the wrong way people do it. Because some people get the right answer for the wrong reasons.

INTERVIEWER: MIT students are sort of a unique group. Do you have a description you could give of how you see a typical MIT student?

GRAY: You know, MIT students are amazing. They're wonderful. They come with a depth of skills that even though I'm a professor here, I look at some of what these students can do and have done, and I sit in awe of that. And having them in the classroom-- I'm obviously having trouble expressing it in words. It's a little bit hard to describe to somebody. And they have all the things you expect this age group to have, in terms of challenges of moving from home to college, and developing social skills and growing up, and in this sense they are entirely normal on average. Maybe more normal than some people perceive, because MIT has a certain perception. But they are just so smart.

And in BioMatrix, I've really gotten a chance to get to know some students really well. And their drive to make a difference in the world is inspiring. It's going to be really hard for them to do what they want to do, because making a difference is hard. But they are so passionately committed, and willing to knock down your door if they think you could help. It keeps me young. So MIT students keep me young.

INTERVIEWER: You've been involved in the translational health science and technology program in India. And I'd like you just talk just a bit about what the goals of that association are. What difference you hope it will make.

GRAY: One of the things I've done, much of my time since stepping down for HST has been focused on, is developing or working with others to develop the Translational Health Science Technology Institute in India. This is a project that grew out of my last few years as head of HST, initially because I was approached by a team of people that came from the Indian government, and from other institutions in India, that were talking to different institutions about how you brought engineering and medicine together. And HST was an obvious model for them to consider. And after they explored this, they thought this is a model that, number one they thought they really needed to have in India. And they thought they needed to create a new institution to do it. And so one thing led to another, and I became a principle involved in that project.

For me the goal of the project is to create an institution that is modeled on HST, that puts engineers and physicians and scientists and maybe business people together in a single academic institution, with different kinds of relationships that are networked across India, and possibly the world, starting from scratch. They made the decision on the recommendation of many that it would not be successful if they tried to embed it into existing institutions. That the likelihood of changing those institutions to accept and to build that was slim to none. Because the difference between disciplines and professions is even more stark in India. For me it was interesting, number one because I'm interested in how do you create these organizations. And we need more of them. But also because increasingly there are students that want to approach problems of the underprivileged in third world countries. And I don't believe that students or any faculty can approach these problems without partners in those parts of the world. And those don't just happen over night. So, by being part of creating this Institution, it's already clear we've created relationships that can support our own students where that's the context. We will not solve those problems by focusing only on Boston and by living in Boston. You actually have to go see it. So that combination of things is what got me interested in it. But the goal is audacious. Create a new institution with a fundamentally radically different culture than currently exists in India.

INTERVIEWER: And what's the status right now?

GRAY: So my primary and official role is to help recruit and then train the faculty for the Institution. So we've had a faculty search the last year, and are in the midst of trying to recruit them. We have a joint search between US based people and India based people. So trying to recruit the founding faculty. We are still in search of a director of the Institute. And I think that's an impediment to having it grow very quickly. We definitely need that. The ground has been broken. They've got space for this outside Delhi. The mental framework for India has now moved to a cluster model. So this is one Institution of several that are to be co-located so that it doesn't stand in isolation. So the whole concept of how do you build a cluster? That's something that's happening in India but affects us. So it's very, very much at the early stages.

INTERVIEWER: I want to move on to some MIT-specific questions, but I think before I sort of leave the research and teaching area, I wonder if there's anything you'd like to say about where you see your research headed? Or where you see HST headed?

GRAY: In terms of saying, where do I see my research in arthritis headed? The biggest challenge at the moment for arthritis work is disseminating, translating our imaging technology and potentially other forms of imaging technology to widespread use. I'm not sure that I said, but we were able to develop an imaging technology that allows you to actually see key macromolecules in the cartilage, which tell you something-- not necessarily everything --about the status of the tissue. In order to see whether or not that's useful at all clinically-- which would be our dream --you actually have to use this technology. And lots of people across lots of cohorts and lots of medical institutions, for that to happen it has to be installed in existing imaging technology, which is just happened now with one vendor. And those studies have to happen. That's not something that I can do myself. So at some level, what really has to happen next has to be done by somebody other than me, and my role can be advocacy.

There's a couple of other areas that-- now that we have this technology --that bring me back to my roots, trying to understand really what matters to these little cells insight cartilage. And what do they care about the mechanical environment? Again, I thought I'd be doing that 15 years ago, but here we are, back. So that's part of what's next on the cartilage side. For me, the HST and more generally, the side of my life which has become the more dominant side of trying to create exemplars of this multidisciplinary ecosystem, that's really what I'm spending a lot of time working on and thinking about mostly through example, in India and other places. With the hope of being able to distill that into things like written documents and white papers. And working with an anthropologist to do some of that.

INTERVIEWER: OK, so you were the first woman at MIT to lead an academic, science or engineering department. And I'm curious to know how about experience felt, to be inside. Or whether it made a difference. Whether it was easy, whether it was difficult?

GRAY: I do get asked often, what's it like to be a woman at MIT? What was it like to be a woman department head at MIT? And I've asked people that, that I know at other institutions. But it's extremely difficult to know what it would've been like had I been a different person, a different gender. So what was it like? It's hard to answer in any concrete way what it's like. But you learn a lot about yourself when you do these kinds of leadership positions, about what you care about, what you're willing to stand up for. You learn a lot about other people. And I would say I grew tremendously as a person as a result of that experience, through meeting wonderful people and being able to do wonderful things. And also like everything, there were challenges that I had to figure out how to face.

Perhaps the only thing I can really say about being a woman is, my husband and I developed a way to talk about that. Sometimes I'd come home and I'd say, it's never what's going well. It's of course what you're struggling with. I'm struggling with this, that, and the other thing. And he would say, just do X. Just do-- And they would be things that, I'd be like, what? Or I'm dealing with this person, and they're going to say this. And I'd be, what? So we developed this phrase, and he says, you know Martha, you have to remember that this is ice hockey, not ice dancing. So the background for that is that we do come with the schemas in the way we think. And so he started to call my paradigm ice dancing. It's hard. It requires skill. And it's beautiful. And you move around the ice. And you can be injured, and blah, blah, blah. And then using the same equipment to first order, there's ice hockey. You move around. It takes skill. But you get slammed into the boards, and that's part of the game. And if you're doing ice dancing, you don't expect ice hockey. So I suspect that my colleagues were equally perplexed at me as sometimes I was as them, probably because they thought it was the other. I would say it made me even more passionate about thinking about how to promote diversity in general.

That it is not about somebody explicitly saying, I don't want women, or I don't want minorities. In my experience, I've never seen something as outrageous as that. It's much more subtle, the ways in which these biases enter. And they absolutely do enter. So as far as being a woman as a student, I didn't believe there was any difference. I thought the problem was solved. Students today think the same thing. It is not solved, and I think people are genuinely trying to find ways to work on it. And I think about building THSTI by the way. I'm thinking, we want to get a distribution of disciplines, and we want a distribution of genders when we start. Because I think if you can start that way, it's a hell of a lot easier than trying to fix it afterwards.

INTERVIEWER: Yeah. Can you expand a little bit about the more subtle ways in which bias comes across? Because I think a lot of people really don't understand what that means.

GRAY: What that means. So first of all, I think most of the ways in which the consequence of the bias tends to be very small. A number of people have talked about this. It's not any one thing. It's the accumulative effect of the little things of bias. Whether it's for gender or something else. I think one of the most sobering studies I've read on this is one where manuscripts and grants were sent to reviewers. And the only difference of what was sent was the names of the authors. Or the principle investigator to obviously women or obviously male or neutral. And it was sent to women and men reviewers. In fields that were say, more male dominant, men and women gave statistically significantly lower scores or reviews to proposals that were written by women. So if this is the exact same content, I don't believe that they picked people who were purposely biased. So I think that's when I say it's subtle. I think we all come with a set of biases, and we rarely know what they are. And so it requires just really being open to the fact that-- and I'm sure I come with them too -- open to the fact that we carry those biases. And it's I think through collective thinking with diverse groups that you have a chance of maybe balancing out the biases.

INTERVIEWER: It would be easy to fix that by just removing names, and having them--

GRAY: Well, the example I gave yes. But you can't write promotion letters that way. And so, the things that many, many people talk about, are ones that if you start becoming sensitive to it, you notice in things like promotion letters, the phraseology that's used about women tends to be different than the phraseology used about men. She works really hard. Really, she works very hard. She's very dedicated. And about the guy, they might say, he is tenacious. He goes after a problem until he gets it solved. That's of course working hard. But they send very, very different messages in the context of an evaluation letter. So to a lay person reading those would probably say they're both great letters. Does that make sense?

INTERVIEWER: Yes. So you have the perspective of being a graduate student here and a faculty member. So mid-career, can you talk to about some of the changes that you've seen at MIT?

GRAY: Are you defining my mid-career now?

INTERVIEWER: I'm calling you mid-career now.

GRAY: I'm old. I think I'm on the last part of it.

INTERVIEWER: Well, I don't know. I interviewed Jay Forrester, who's 92.

GRAY: Yeah, OK. Yeah, yeah, yeah. By that. Well so I've been at MIT for 30 years. And in some ways I know the Institution much better. And in that way, I see it differently than initially. And in other ways, it's changed profoundly. So perhaps the most overt way it's change profoundly is its whole thinking about the life sciences. So at the time I came to MIT, life sciences was for those guys at Harvard for first order. There were people here, but it really was not at all part of the ethos. I think now you will find people that are concerned that the pendulum has swung too far the other way. That we've made a tremendous investment in the life sciences, which is a place by the way I do think MIT has a hugely important role to play. But it shouldn't be a Life Science Institute. So that's been a profound change that at some level has been directly related to my life at MIT. There's no question it's more diverse. I think I was the twelfth engineering woman faculty, which I didn't know at the time when I was hired. Some small number, which I think I'm glad I didn't know. I mean now there's many. I mean I used to know all the women faculty. I should make it my business now, but I don't yet.

INTERVIEWER: Have the students changed?

GRAY: As generations change, I think that gets reflected in the student body at MIT. So I have a perception. I don't know if I were going to be very scientific about it, whether it would be born out in reality. But I would say I've been struck in the last five plus years the degree to which incoming students-- graduate students and undergrads --come with an idea of changing the world, of thinking globally. I don't remember that being something people wrote about in their application essay or talked about in application interviews. So either we've changed and therefore that's who I see, or that's reflecting more of a generational change. And who knows what the next generation will be? There's never a shortage of things for people to do and have an impact on, but that seems to be something that's much more prevalent now.

INTERVIEWER: Do you have a sense when you think about MIT nationally or globally, what it is that makes MIT unique?

GRAY: When I'm in India for example, I hear many comments about people's perception of MIT, as well as other places in the nation. If I try to synthesize what it is I think people say, it's recognized clearly as being a place of innovation. They look at this as the pinnacle of where people who are innovative come. And they'll ask, what is it that you do? What's in the sauce at MIT that makes it happen? I don't think it's only MIT. I think it's the ecosystem, but certainly this is a very creative place and it's perceived that way. And it's also perceived for its strength technically. That this is where radar was invented. And those things remains the kinds of things that you hear people talk a lot about. It is very highly valued outside. It's always nice to hear that of course being part of MIT.

INTERVIEWER: Are there particular characteristics that you think the Institute has that makes it so innovative? Why here and nowhere else?

GRAY: So trying to think about what it is here at MIT that makes it such an amazing innovative cauldron. I don't think it's the only place in the country or the world that has an awful lot of innovation happening. And I think it would be at MIT's peril to think we're on top and we'll stay there. But this is a place where, pretty much if you want to get something done and you're passionate about it, you can get it done. That's not universally true, and of course different personality differences can make that easier or harder. But I would say that even from my days as a students, you can do what somebody tells you to do here, but there is a real openness that I think does not happen in lots of institutions that says, if you want to drive it, and you want to make it happen, whether you're a student or faculty or a staff person, you can do that. And there's people at every level in general that are highly valued. It's not so much of a class system. And again, none of this is universal, and it's highly personal. But I think those things tend to be huge enablers.

And if you do something, you'll be recognized for it. Again, doesn't always happen, but I think it's important for MIT to actually do that. Because that generates people who really try to make things happen. And it's ensconced in an incredible ecosystem in Boston. And if you picked up the entire Institution and moved it into the middle of the desert, even with air conditioning, without any of that I think it would dissipate. Because that adds enormously to the vibrancy of the place. But this is a question so many people want an answer for, of what is it that you do institutionally that makes it the way it is? And partly it's the people and the people who generate that culture. But it's the leadership that has to continue to make sure that they pay attention to that culture and that they attract those kinds of people. Which I think all department heads try to do.

INTERVIEWER: What if I asked you specifically about the School of Engineering? What do you think its chief strengths are?

GRAY: One of the benefits of being head of HST, well I mean this would be true for any department head, I got to know many, many departments. Both in engineering and science and at Harvard and the hospitals, just by virtue of me doing my job. But in particular I spent a decade sitting on Engineering Council, which is where all the department heads in engineering make. And again, each department has its own personality, but the School is extraordinarily strong. And the diversity and the quality of the kinds of work that gets done at least insofar, I certainly don't know everybody, but in assessing it through promotion cases they come through. It's remarkably diverse I think in ways that probably the outside world would have no way to appreciate. They just don't see it all. And I think that diversity in its size adds to the strength an opportunity for all the students. I think like every institution it's struggling with how do you think through engineering education of the next decades and centuries? And their different views on how to make that happen. And to me it's a huge positive that people are thinking about that, because you stay on top and you stay high quality, because you continue to innovate and make it better and better and better. And so the fact that it's full of people that are devoted to make that happen.

One thing people perceive about MIT-- and it is a research Institution --and sometimes I hear people say, but nobody cares about teaching here. And that has just not been my experience at all. I'm sure there are some individuals that don't place a value on it. But my experience has been-- that from the department head level to the faculty level --that a huge amount of attention and care is paid to that part of education.

INTERVIEWER: That's been my experience in talking to a variety of people. That it's much more important than I would have expected it would be.

GRAY: So I think that's one thing that may well-- Again, I don't know if my perception of the other institutions is equally flawed therefore. But I do see that as a huge strength of engineering at MIT.

INTERVIEWER: Is there anything unique about your department that you could point to?

GRAY: About electrical engineering?

INTERVIEWER: Um hum.

GRAY: Electrical engineering and computer science here I think is interesting because it is electrical engineering and computer science. And when I first came, they were highly integrated. In the middle of my years here, while they stayed in one department, they became much more intellectually separated and faculty separated. And now that's come back together. So I think compared with many other places around the country, at least based on my somewhat limited experience, electrical engineering and computer science has been able to evolve and weather changes in the field, partly because it's big and diverse in that way. The challenge there is, how do you define what the path is for students, in a way that people feel is sufficiently deep and rigorous, and sets them up for whatever direction they tend to go in?

INTERVIEWER: Do you have a vision for how you'd like to see MIT develop, say in the next generation?

GRAY: You know, I do think about what I'd love to see the MIT of 2050 be. It pertains to this issue of creating opportunities for multidisciplinary students and faculty. Not just in health, but in other areas. So I think a key to innovation is creating a forum in which people do bring disciplines together. It's not the only form of innovation, but it's a huge part of where I think innovation comes from. And as I said earlier, I think creating that climate and the culture and the reward structure, and the educational paradigm, and all those things that go with that, is a different mindset than disciplinary. What I'd love to see is for MIT to say, we started this in 1970, we thought about it. Now we're going to make this an Institution where you can come either way. You can be the next absolute superstar in this discipline, or you can be an expert in something but living in this very multidisciplinary culture. So HST's not the only place now that has this kind of culture. It's perhaps the most well developed, but engineering systems division is another example of something that at least conceptually draws on many different disciplines to solve big systems problems. And there's an effort in energy.

There's a tendency now to separate the education from the research, and keep the education disciplinary or department specific. And I think ultimately it needs to be able to manage as an Institutional level both those models. And I think then it will continue to be at the top, and you'll attract spectacular people. So that's what I'd love to see.

INTERVIEWER: So what's kept you here for 30 years?

GRAY: So I've now lived in Boston longer than I've ever lived in Michigan. And I have no designs to move. Partly MIT is an amazing place, and I've had really a remarkable experience here. And the other honestly is that I have social, personal roots. I have a fabulous family and wonderful husband and lots of friends. And I just can't imagine ripping that up and moving, if we talk about moving out of the Boston area. And I've been able to do truly remarkable things since I've been here. I've had my regular faculty experience and head of HST, which was a whole other thing. And now who knows what it will be really, the next decade. But I can't think of a better place than to try it out here.

INTERVIEWER: We have just a few more minutes. What haven't we talked about that you think is important to mention or cover?

GRAY: I don't know. Perhaps the only thing that I might add, that you haven't touched on at all in your questions, that relates to the more personal side of living a life at MIT. One of the reasons I said as it graduate student, I'm done with MIT, is not that I didn't like it professionally. But I was seriously concerned of whether you could have a life here. And I talked to people, can I have family? I no longer wanted to be nursery school teacher, but I didn't want to give up all the other things I dreamed about as a little girl. And I would have to say that though there have been many, many challenges, that I-- among many other women and men here --have a reasonably balanced, wonderful life that has been integrated with my life at MIT, but is certainly not only MIT 24-7.

And I think as young people try to decide what career path they have, I don't know that I personally have done what I could do, and I know generally we haven't done we need to do to convey the fact that even though they see us in one context, that if they got a sense of the whole picture, that this is really a marvelously fulfilling way to spend your life. Not just for professional reasons, but personal reasons. I became director of HST when my youngest was six months old. So I'm sure I would have spent more time at home had I not been running HST, and now I get more time. But I would not have thought that remotely possible when I first started at MIT. And I hope that continues to be true for everybody that comes. I think a lot of making a successful Institution of 2050 is making it successful for people to actually live. And not just is it professionally satisfying? Your happiness is so much more than MIT per se. INTERVIEWER: That would be a good thing for more people to recognize.

GRAY: Yeah. Not everybody would agree with me on what I just said, is also true.

INTERVIEWER: Anything else?

GRAY: No. That's all that comes to mind. You've touched on an awful lot of my life.

INTERVIEWER: OK. Then I think we're done.