Interviews of the Margaret MacVicar Memorial AMITA Oral History Project, MC 356
Massachusetts Institute of Technology, Institute Archives and Special Collections

Martha Goodway – class of 1957

Interviewed by Natasha Balwit, class of 2016
July 16, 2013

Also interviewed by Madeleine Kline, class of 2020
February 2, 2018

MIT Libraries

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Martha Goodway (SB General Engineering, 1957) was interviewed by Natasha Balwit (SB Urban Studies and Planning, 2016) on July 16, 2013 at the now-defunct Voltage Coffee and Art in Kendall Square. Goodway was interviewed a second time by Madeline Kline (SB Biology and Chemistry, 2020) on February 2, 2018 at Goodway's apartment near Kendall Square, Cambridge. This oral history is the result of both conversations.

Goodway minored in political science at MIT and was one of just 19 women awarded a degree in 1957. She subsequently studied Islamic history at Harvard on a National Defense Scholarship and then worked on the Polaris program as well as on atomic testing.

Twelve years after developing an interest in conservation science through a friend and mentor at the Objects Conservation and Scientific Research Laboratory at the Museum of Fine Arts, Boston, Goodway was hired as a metallurgist by the Smithsonian Institution's Museum Conservation Institute. At the Smithsonian, where she is currently Archaeometallurgist Emeritus, she researched and re-created metalwork from around the world. For example, Goodway determined that the crankcase of the Wright brothers' aircraft engine was made from an aluminum alloy – disproving the belief that aluminum was first used in airplanes by the Germans. In addition, she and a colleague determined that 17^{th}- and 18-century harpsichords makers used iron containing phosphorus, not steel, to strengthen their wires. She also consulted on the renovation of the Statue of Liberty in the 1980s.

A pioneer in the field of archaeometallurgy, Goodway was the first metallurgist to be employed in a U.S. museum. She was also the first woman elected president of the Historical Metallurgy Society.

BALWIT: Thank you for meeting with me. Could we talk first about your time at MIT?

GOODWAY: I graduated MIT with the class of 1957, which meant that I entered in 1953. That was the last year that GI's could start on the GI bill. MIT had a yield. That is to say that the people who accepted their acceptance was much higher than MIT expected, and they were really caught short by this whole thing. They got the freshmen together – in [lecture room] 10-250, of course – and said to us, "Look to the right of you, look to the left of you. One of you will not be here next term." They flunked out a third of the class.

They were pretty careless, it seems to me, about the way we were treated, or at least the way women were treated thereafter. It didn't really hurt them to flunk somebody out. That's just what you do when you're at MIT. At Harvard, there's this saying that Harvard professors are not hired to teach; they're hired to grade. But MIT professors, at the time, seemed to be around not just grade, but to flunk. It was just amazing.

But there was a great advantage in having so many GI's from World War II. Many of them had seen really bad times. There was this running sense under the hilarity of college life – this basic seriousness. I'm not sure that the GI's were responsible for it or whether that's just MIT.

I heard a Harvard man say a few weeks ago, "Harvard looks back." But he had done some fairly serious look into MIT's early records and he said, "MIT is different. It looks forward."

BALWIT: You also went to Harvard, right?

GOODWAY: I went to Harvard after MIT. Not directly afterwards, but I went to Harvard to hear Sir Hamilton Gibb [historian of the Middle East Hamilton Alexander Rosskeen Gibb] give his series of lectures on Islamic history; he was famous for this. Harvard had hired him, and it was my last chance to hear him. I'm so glad I did because that's what I was interested in.

I had a degree in Course 9. It was something entirely different in those days. It was the School of Science, that was 9A, and 9B was General Engineering. Then there was a 9C, which had to do with science teaching. John [John T. Rule] was in charge of it, the whole department. He later became Dean of Students. And I thought to myself, "That's a perfect fit, an absolutely perfect fit for me."

In those days, at the most, you could take one elective per term. The different specialties had certain things you had to know and could be stuffed into four years – and people that were hiring [graduates] would look to see whether you had all of these courses. Now, of course, the fields are so extensive it's impossible to do anything like that.

That has been, I think, a wonderful freedom. There are people that are now majoring in political science; there was no such department at the time. But MIT did have nothing but top-level people – few of them, but top level. I just looked at that and I thought, "What an opportunity. I won't get a teaching assistant or anything like that." I took things like international law with our expert on the Panama Canal.

It was an opportunity that I could see and I wanted to take. But the first thing I had to do was to get out of physics – I thought I was going to be a physicist. Well, they were kings in those days because they had produced the bomb, so I tried physics. And one day I went home and said to my mother, “I can't stand it. They're dealing with nothing but massless particles nd frictionless surface.” And I rubbed the table and I said, “Surfaces have friction. And I don't know when they're going to deal with this.” In other words, I was talking like an engineer.

BALWIT: Really? Wow.

GOODWAY: Was that strange? No.

My father had worked on radar during World War II. When the war was over, his boss, Percy Spencer [an American physicist and inventor who was considered the leading expert in radar tube design while at Raytheon], had this funny idea that you could cook with radar. He chose four engineers, not one of whom was a cook, to work on this idea, to see if it could be made. Because they weren't cooks they had some spectacular failures in the process – but they essentially developed the microwave oven. It was first produced by Raytheon as the Radar Range. And, of course, now no kitchen is complete without it. I must say, I enjoy seeing them. I say nothing, but I notice them!

My mother's uncle was chief engineer of Rhode Island. And the next generation, my great-great-grandfather, his father was a civil engineer also. And another one of my great-great-grandfathers made his living as an inventor. So maybe I came by it that way. I did not apply anywhere else but to MIT.

BALWIT: Really? Did you have a lot of encouragement from your family?

GOODWAY: I don't know, really. At this point, I really can't tell what was on my mind, but I wanted to go to MIT. I had an English teacher in the Boston public schools who knew then that I wanted to go to MIT, got an MIT catalog, read it, and discovered that I was not going to get any more English instruction, which was terrible for my classmates but wonderful for me, because she put me through everything that she'd learned at Harvard.

Of course, in those days, women at Harvard went to Radcliffe. When I went to Harvard, we were both Radcliffe and Harvard; they were making the transition. You would go to the Radcliffe office with a problem and they'd say, “Oh, well, go to the Harvard office,” and vice versa, so we were without much help. In those days at Harvard, they filed the final exams in one of the small libraries, in which a woman could not go. It made things rather difficult.

BALWIT: What about at MIT?

GOODWAY: MIT was a bit more fair, in spite of the fact that-- I can't say that they were encouraging women, but when I had said to my mother, “I want to switch from the School of Science into the School of Engineering,” she said, “Well I don't want you to lose any of the credits I've paid for.” And I thought, “Well, I earned them.” But nevertheless. So I said, “Well, I'll start by taking one of the required courses in the summer.” That was Metallurgy for Engineers. They were very smart, because they had to teach this course as a service to the Engineering School. So I had an absolutely wonderful introduction to metallurgy. And it was years later that I realized why they put top men teaching that course. They'd teach sections so they didn't have to teach more than a few weeks at a time. But they were using it as a recruitment device, and they recruited me.

BALWIT: Just to get people into that department?

GOODWAY: Well, I think that's what was going on. But I was just entranced. It made sense to me, and that was very helpful in metallurgy. I'm a person who visualizes things, so I could visualize the arrangements in the metal crystals. It was a nice fit. I thought to myself, “Oh, I'll take another course in metallurgy, why not? This is really interesting stuff.” And so I did a major in metallurgy and I did a minor in political science.

BALWIT: Which would explain why you know all about Washington!

GOODWAY: Some things, yes.

When I graduated, I finally got a job. It took forever, because many people who were hiring were unaccustomed to seeing a woman engineer. They probably had never interviewed a woman engineer before. They just didn't know what to do with this strange creature.

When I finally got a job and a little bit of money, I joined the Museum of Fine Arts, which was one of my favorite places. To this day, I know exactly how to get to the Egyptian collection: you walk up the main set of steps, turn immediately right, and you're in Egypt.

At any rate, for new members, they had a series of open houses, one department after another, and they'd show you how they ran the department.

They were very, very open about it. And on one of these occasions they opened up the museum laboratory. I didn't know that museums had laboratories. What I didn't know, and most people don't know, is that the laboratory in the Museum of Fine Arts here in Boston is the oldest continuously running museum laboratory in the world, not just in the country. For that reason, the director of that laboratory was essentially the dean of all museum laboratory directors. He would hold international meetings.

You could put everybody who was interested or working and came to these meetings in a relatively small room. But they came from the Louvre, from Asia, all over. And when I first walked into the museum laboratory on that initial tour, I looked around and I recognized every piece of equipment. Not only did I recognize it, I knew how to run them.

The director, Bill Young, was using things like X-rays, and people there thought they were subject to danger, so he put together a scientific advisory committee. Half of them were professors that I'd had at MIT, so he could find out very quickly whether I was any good or not. He just asked them, and so he became my sponsor [in my career]. He got to know me, but it took almost 12 years for me to find a job for a scientist in a museum laboratory, there were so few.

When he was holding the third of his international meetings, the man whom the Smithsonian had hired away from the British Museum was present. He was looking around and trying to fill out his laboratory roster. He went to Bill Young and said, "I'm looking for a mineralogist." And Bill said, instantly, "You don't want a mineralogist, you want a metallurgist, and I know exactly the one." I'm not sure that anybody else ever applied for the job. But of course, one had to go through the federal system. I did get the job [as metallurgist at the Smithsonian].

That meant I went to Washington, which I do not recommend as a place to live. It's a beautiful place to visit, and I think everyone should. But they didn't get the vote until the 60s. Nobody had the vote in the district until the 1960s, so they're only just learning how to run things.

BALWIT: I'd really like to hear about your job at the Smithsonian.

GOODWAY: The first month I was there, the first thing I remember having to examine was a watch – a pocket watch, 18th century. It was made of gold, it had a lovely movement inside. But it was a handful. I mean, they were not small at the time. It was very heavy because it was gold. It had belonged to George Washington. It was inscribed on the back as a gift to the Marquis de Lafayette in thanks for his help in the Revolution. You can imagine how careful I was in dealing with that! (I was going on about the rules of dealing with museum objects, and my friend said, "Well, the first rule must be, don't drop it!" I had to agree. That was rule number one!")

But also, that first month, I had gone to one of the concerts of early music, because the Smithsonian has a marvelous collection of early musical instruments. By early, you can mean right up until the 19th century, but a lot of the collection is 18th century. I just became entranced with it, because I'd had a very good training in music. My mother sent me to a music school here in Boston that no longer exists. I had about all of the Bach I cared to play in my life, but I got good training. So I was sitting there and really hearing it, and hearing the music and the voices for which it was composed. And let me tell you, that's very different.

When I had worked on a harpsichord wire project [at the Smithsonian] for quite a while, I was invited by Igor Kipnis [American harpsichordist, pianist and conductor] to his studio, which was in Connecticut. He had bought a genuine Viennese fortepiano. This is a piano that has a wooden frame; it's not one of these pianos that has a cast-iron frame. Then he sat down for an audience of one and played the Moonlight Sonata of Beethoven. The first movement is relatively simple, and I had tried it on every piano I had access to. I could never make it sound right. And he sat down and just played it. And all of a sudden, I thought, "Oh, that's the kind of instrument that Beethoven composed for!" It was a wild moment, definitely.

KLINE: How was it that you investigated the makeup of harpsichord wire?

GOODWAY: Well, the man who is in charge of the conservation-- We don't call them restorers; we call them conservatories. That's to make a distinction between the approach that a restorer makes, which it to fix things up, maybe re-paint and so forth, and the conservator, which tries to retain as much of the original object as he possibly can. The conservator of musical instruments had a 3 x 5 file card, and pasted to it with two bits of tape were these little nubbins. They were slightly larger than a period in printed work. They were very small. And he said, "I think these are the remains of original 18th century wire. Can you do anything with this?"

And I said, "Well, I don't know, but I'll give it a try." And then, when he went away and left this with me, I thought, "Oh my God, what am I going to do?" But in the meantime, while I was brooding over this project, he also spoke to conservators, his opposite numbers in large museum collections, that there might be some remains of 18th century wire. Well, everybody in the field up to that point was convinced there was no wire of the period left because the wires break, and they come to being into the conservation labs with no strings on them, et cetera. So they strung them up as best they could in order to play the instruments. People began looking – seek and ye shall find.

It was a marvelous example, because someone had done an entire X-ray of the instrument before they went to work on it to find out what was hidden – hidden parts that they wouldn't expect. They found a little loop of wire that had been glued, because the instrument had been re-glued along that point at some time. There was this little bit of wire that was glued in. There were these bits and pieces. Then they began to find that that were little drawer stands that were separate – the instruments were separate from their stands – and that was a little drawer in one of them that was full of original old wire.

Then there was a piece of red wire, which I needed – a long piece of red. They were described as being red, yellow and white in all of the 18th century manuals. They didn't tell you what, just told you red, yellow and white. So one of the red wires – which is at the lowest end of a bit harpsichord – I got a sample, and a long enough sample, maybe 10 centimeters. I had four pieces.

I was astounded, because when my mother took me to Washington to see our nation's capital, of course, we went to Mount Vernon. My mother, being a thrifty New Englander, said, “Well, you may buy one postcard.” And years later, I came across the one postcard I bought. Can you guess what it was of? It was a picture of the harpsichord at Mount Vernon from which I got a sample. Can you imagine such a coincidence? Isn't that marvelous? I was just overtaken. I had forgotten what I bought as a postcard. I remembered I was allowed only one.

BALWIT: That’s amazing!

GOODWAY: At any rate, as you could tell, those two little bits pasted to the 3 x 5 file card began a whole program. By the time we finished, I wrote a book with the dazzling title of “The Metallurgy of 17th and 18th Century Music Wire” [written with Jay Scott Odell; published by Pendragon Press in 1987]. You know that's going to be on *The New York Times* list! It was very interesting.

Anyway, I got the analysis of the white wire, which was so surprising that I eventually wrote it up. I got not a research report, but a research article published in *Science* on the composition of this wire. [“Phosphorus in Antique Iron Music Wire,” May 22, 1987]

Everybody was certain it had to be steel, because up at that part of the upper end of harpsichord wire, you can do a very simple calculation knowing what the pitch is and the length of the strings from the instrument, you can calculate what strength it has to be. So there is no question about it having to be quite strong. The upshot of it was that it wasn't steel at all. It was iron where the carbon was so low that even the United States Steel couldn't find any in it with their most sensitive instruments. It was hardened with phosphorus, which explains why you cannot have any carbon, because the two fight and make iron very, very brittle.

You could not detect any carbon. And it was therefore below the detection limits of the instrument, which meant it was, at the most, 10 thousandths or a few thousandths of an inch of a percent of carbon. And they would say – and I love the phrase, I've heard it for 10 years at least: "But they couldn't do that then!" And it's perfectly obvious they did it routinely. So that's one of the things you have to understand in dealing with these old materials: that you cannot omit possibility, that some of these compositions which seemed amazing could exist.

Now, nobody knew phosphorus existed at the time. Well, how did they get the phosphorus? Well, they didn't. It was first stuff that came off the blast furnace when they were smelting the iron. And the worst iron to make into steel, actually, was the best iron to getting the phosphorus. What they did was to take this iron-- Because phosphorus containing iron melts earlier than steel, at a lower temperature, it's also more fluid. These are things that in their favor, being able to get the fraction they went and worked on. And then they burned the living daylights out of it.

I mean, it was just marvelous when I finally got the pieces put together of how this could happen. It made sense of some of the few records that we have of making iron wire in the 17th and 18th century. It all fit. Well, that was my first paper in *Science*.

BALWIT: You must have gotten recognition for--

GOODWAY: I've been on the floor of the House of Representatives, which no non-representative is supposed to be.

BALWIT: How did you get there?

GOODWAY: Oh, I knew somebody. And they had sent the mace [the ceremonial Mace of the House of Representatives, a cast-silver globe and eagle sitting on top of a rod, a symbol of the House's legislative authority], an important piece of regalia. We have not very much regalia in America, as you know, but this is a very important piece. It's a working piece of regalia because a representative walking into the chamber has only to look to see where the mace has been put – there are two positions for it – to find out whether or not they're meeting under the committee of the whole rules or not. There's a peg that they put on the bottom. So they put it in the little stand, and it's an indicator. It's a working piece.

I thought, "Well, I'm not leaving this thing on the bench in the laboratory overnight." I called up my friends in numismatics and I said, "I've got the mace from the House of Representatives. Could you possibly have any room overnight in which to keep it safe?" Yes, they did. So each afternoon, with the person in front of me making sure that nobody bumped into me, we would take it up to numismatics, and it spent the evenings resting on bags of early Spanish coins from America, from the New World. It was a perfectly ordinary thing to do in that environment. I spent 41 years in that environment!

I had a fellow woman, an archaeologist from Turkey, who had discovered the source of some tin, some cassiterite [a mineral consisting of tin dioxide]. Up to that time, archaeologists were assuming that the tin for the Bronze Age came from-- "Oh, it must come from Britain or southern Africa, or in the Far East." I mean, they had all sorts of ideas. They were not looking in the Middle East, where the Bronze Age began.

Anyway, she said, "Have you ever come across any cassiterite?" And they said, "Oh, yes." They were panning material in a particular stream in the Taurus Mountains, and they came across some crystals which they had identified as cassiterite. And she said, "Well, could you tell me exactly where?" And they did. So she went to that spot, went uphill into a cassiterite mine, in the Middle East, where it belongs.

She had no idea how to publish something scientific, but we got the scientific work done that was necessary. You have to dot all the i's and cross all the t's. But we got it published in *Science* with at least one other Turk that I had worked with before. ["Kestel: An Early Bronze Age Source of Tin Ore in the Taurus Mountains, Turkey," April 14, 1989] It's not a very large community of people that are in archaeometallurgy. At least, it wasn't then. So we knew each other and got that published.

BALWIT: Didn't you also work on the Wright flyer [the plane the Wright brothers flew four times on December 17, 1903]?

GOODWAY: Yes. There was the time I took my trusty Plymouth Valeant and drove down to Kitty Hawk [North Carolina] and kicked up the crankcase from the Wright flyer. That part had always been lost. The story that Orville Wright had given was that the plane had rolled over after they had the flight and broke the crankcase. I do not believe that for a minute, because I saw at least one imprint of a hammer. What I think is that the missing corner was aluminum that was being recycled.

Now why do I think that? I think that because I went to the Library of Congress. They don't just hand you out a little pocket diary in which the records of that flight were taken by Orville Wright, but they have it on microfilm. I read the whole year. At the end of the diary, there was a space with notes for the next year. And there was this note that he had taken patterns from Maltby. And I thought to myself, "Well, I knew Maltby was his pattern maker." And I thought, "Oh, I understand this man. I grew up with one." He was a development engineer. This man was already thinking about the next plane. He was changing the design of the engine already. I mean, that was in his head to do. He must have had something already in mind before he went to Maltby.

The historians take what Orville Wright said 30 or 40 years later about the first flight as being gospel truth. And I thought, "Nobody remembers what you didn't do 30 or 40 years later, especially if you're a development engineer."

At any rate, the original part, the broken one, we knew was around somewhere, and the National Park Service found it. They wanted us to authenticate it, because we had the rest of the plane, finally. I went down to Kitty Hawk and wrapped it in wool, and put it in my trunk and drove to the Smithsonian. And it fit, exactly, the rest of the plane. And even to the sealant – which, of course, had hardened in the meantime – the pieces of sealant keyed together perfectly. And then we really over-egged the pudding, as my mother might say, by analyzing the sealant on both sides. It had aged into some peculiar set of chemicals. But they were identical – both sides: ours and theirs, so we felt very comfortable about it. But then I said to Park Service, "There's a little crumb on that broken edge, and I'd really like to look at it." And they said, "Oh, OK, you can take it."

Well, I was in good standing with the Park Service, because when they were considering putting a new frame inside the Statue of Liberty, and I said, "Don't do it!" They later discovered why I said that, but at any rate, they trusted me and essentially gave it to me. I prepared the sample, and looked at it and looked at it, and I put it on the SEM [scanning electron microscope] and cranked up our SEM as high as it would go. I still saw nothing but general aluminum, standard-- To this day, I can't tell you why I felt something more was going on. It was strictly intuition.

BALWIT: Did you ever find anything?

GOODWAY: Well, our director at the time had given away our SEM, and I don't know why. I never got an explanation that made any sense to me. So I went to NIST, the National Bureau of Standards, which is now the National Institute of Standards and Technology. At any rate, they had a SEM, and they also had somebody who could take a very tiny sample and prepare it. It was the tiniest sample she'd ever prepared, but she coped with it. It was amazing. And they put it on.

One day, I got a phone call. And without so much as a "Hello, Martha," it was "We found aluminum!" I had to get my own thinking in gear because I was working on something else. "Oh, oh, aluminum." It was essentially duralumin [an aluminum alloy], and it was [from] 1903, it wasn't 1909, which, according to the history of metallurgy at the time, was when the first duralumin was discovered.

They had figured out that you had to give it a heat treatment, because the aluminum is hardened with copper the same way you harden sterling silver. It works, and it's still used. But if you could give it a heat treatment after it's been made into sheet, out of the copper, it will make little circles that are only one atom thick of the copper. And that's just enough to prevent very much slip in metal. So they used it for the first time-- The Germans were doing this in 1911. I think it was the dirigible frame that proved that it could be used, et cetera. This is all known history.

And I said to myself, "Hah!" I had handled the [Wright Flyer] crankcase, and it was very thin-walled. Orville Wright was saving as much weight as he possibly could. The walls were very, very thin. There were strengthening ribs but, I said to myself, "I know how this happened." In order to make this size casing with the sections that thin, they had to preheat the mold so that the aluminum wouldn't freeze before it filled the whole form. In 1903, aluminum was very dirty. I mean, this aluminum had at least a percent of iron in it. It had silica, it was dirty. But it was the available aluminum of 1903.

So I said to the young man who called me, "You know you can't use the standard curve for-- That was made with much purer copper. We've got to make some copper that's as dirty as 1903 copper, and then aluminum. And then, having done that, we can figure out at what temperature the mold had to be for at least this sample that had been taken."

And he, being a good southern gentleman, he sat there and he studied the ceiling for quite a while. Then he agreed. I had a record, I had two papers in *Science* already, and the support of a very high-ranking metallurgist who had told him in no uncertain terms that I knew what I was talking about.

The upshot of it was that they reproduced the dirty aluminum and then made a model of the particular section of which my sample had come, which was quite thin. They wouldn't use a huge standard flask for holding the sand; we had coffee tins. And these coffee tins of sand with a hole in them were heated to different temperatures. We just wanted to get some idea that we proved that this aluminum had to have been from a mold that had been pretty heated, to above 100 degrees centigrade.

We finally got that one published in *Science* [“Precipitation Hardening in the First Aerospace Aluminum Alloy: The Wright *Flyer* Crankcase,” Nov. 11, 1994] It was really exciting. To this day, I don't know why I knew something more was going on in that little nubbin of aluminum. And I proceeded to find a TEM, an available TEM to see it. It was--

BALWIT: Just intuition.

GOODWAY: Yes. And when we got the results, I could understand why it happened. But by that time, I had been through enough samples that I knew that to expect things that the history of metallurgy didn't tell you, no matter how distinguished the historian,

All my life I was paid women's wages. But when I went to work at the Smithsonian, at least I did something that was exciting and fun to do. And I think it was a good choice.

BALWIT: And people listened to you, even though you were a woman?

GOODWAY: Eventually, yes. Eventually, I established a record. Yeah. In fact, when I was at the Statue of Liberty conference, I gave a paper there. And apparently, I made enough sense to the man who was in charge of the testing of the iron from the Statue of Liberty's frame that we began exchanging Christmas cards. [Goodway was a consultant on the restoration of the Statue of Liberty in the 1980s.]

I got a lot of help from people who were formerly outside of the field. When I asked for help, for the most part, I got it. And I could not have done a thing without-- There was a professor of physics in Iowa, Bill Savage [William R. Savage, Professor of Physics and Astronomy at the University of Iowa] who had a shop that built things for the physicists. He had them build a torsion tester, so we could measure the torsion margins of these four samples that were long enough, because I would not break them.

I got that question over and over again, “Oh, if you want the strength, why don't you break it?” Well, a lot of these things were little nubbins and little bits. You couldn't put them in a tester to begin with. And then these four samples that were, in my view, very long-- I was not going to break them, because then you have two pieces that are not the same as the original wire.

You might very well have fault in actually pulling things, because wires are, after all, very thin, and they might break at the clamps or some other places than you want them to do. But you can get the strengths from the hardness, so we use the hardness to get the strengths. That bothered some people who didn't understand if you want the strength, why don't you go directly at it? In any case, we had these four samples. I had red, and yellow and white wire in those four samples. Thank goodness. I had all varieties, so we could do the torsion measurement. At any rate, the equipment I went out to Iowa to take this data was a laser hitting a little mirror that was attached to the pendulum with a laser light. It would reflect to the opposite wall, and there were a whole set of meter sticks hammered into the wall. Every 10 swings I would measure where it had gone.

The interesting thing was, one day, when I was talking with Bill over the telephone – I was in Washington, he was in Iowa – and all of a sudden, both of us had the same idea almost at the same second. What did Coulomb [Charles-Augustin de Coulomb, French military engineer and physicist; developer of Coulomb’s Law on the electrostatic force of attraction and repulsion] use as his suspensions? I said, “Bill, the Dibner Library [of the History of Science and Technology at the Smithsonian Institution] is over my head. I'll go up and find out. I'll see if they've got the Coulomb memoir, a torsion memoir written by Coulomb.” And he said, “Oh, great.” I go tearing upstairs, because Dibner had a marvelous collection of these classics of science. I asked the librarian, “Do you have a copy of Coulomb's torsion memoir?” “Well, of course we do.” Silly me. Well, at any rate, she went and fetched it. And of course, it doesn't go out of the library. So I sit there. And I'm leafing through it. And my French is good enough that I could just glance at it page after page. And finally, I got to a page [which included what I was looking for. At which point I went, "BINGO!" in this quiet library. And there were three people there. Heads went up, so I had to explain: Coulomb not only had used three pieces of – amongst other things that he used, silk and so on – he used three pieces of the different kinds of wire. It was absolutely marvelous. There was all this data about what this wire was like and what the torsion modulus was.

It was a big "wow" because nobody knew that here was a very good experimentalist in the 18th century measuring 18th century wire. Up to that time, the only data that we had was published by someone who had used very medieval ideas. He had – how, I don't know – gold being stronger than silver, being stronger than copper. It was in order of value rather than in order of strength. I was able to show that his iron figure was OK. But the rest of them were all wrong.

We had this data that nobody would trust, and quite rightly. This was absolutely amazing. Nobody knew it existed. And there were people who'd been through the – I forget; It was the physical sciences publication – looking for data on anything musical. And of course, they missed this.

BALWIT: They just overlooked it?

GOODWAY: They didn't read everything. It wasn't in the title. You know, he just used it. It was part of the materials that he was measuring. Then we could compare our results with his results. We could say, "Look, what we're getting in the 20th century is OK, because it fits nicely the data that Coulomb got in the 18th century. So we can use the data that we had, and that was very convincing. Because you worry about age effects. I mean, even though in metallurgy, you say to yourself, "Well how do you know? I mean, that's one of the things you worry about. So it was a wonderful. Every once in a while, that sort of thing would happen. It was like the Turkish archaeologist asking, just casually asking these guys where they'd found any cassiterite and then just going there and walking uphill.

BALWIT: It's like an adventure story--

GOODWAY: Yes, I went out to Turkey. That's the sort of thing I find exciting.

BALWIT: It sounds so exciting.

GOODWAY: Well, my first paper in *Science* on the phosphorus in iron got reported all over the place: English newspapers, *Scientific American*.

BALWIT: What about your being a woman in these environments, doing novel work?

GOODWAY: Well, the position that I'm in as a minority, as a professional, is not to annoy too many people. And sometimes that takes some doing, because you just don't know where their annoyance points are. You have to do a bit of guessing about what they'll tolerate and what they won't, and that can be very different. That was like the professor who met me on the steps of 77 Mass Avenue [when I was about to graduate from MIT] and said, “Women don't belong in science.”

There are people that can do that, and progress by annoying people. But certainly not in this field of whatever it is – archaeometallurgy, I suppose. You've got to give it a name. I'm Archaeometallurgist Emeritus at the Smithsonian, the Museum Conservation Institute. They've been very kind to do that for me. But I've worked on things like that.

One other thing I am interested in is traditional ironmaking in India. Several villages took iron, which was already smelted (but not in great quantities), put them in little crucibles, and turned it into the kind of steel that you can make into beautiful swords. And they figured out that they couldn't make very large crucibles, because the weight of the hot metal would certainly fall right through it, so they used as many as 50 of these in one furnace. They would fire 50 at a time. You can't make them strong, you make them small but plentiful. Wonderful. The English were, at that time, beginning to think of the idea of crucible steel. That was essentially an alloy. And then they had a terrible time because they couldn't make a crucible that would stand the temperatures they had to use.

I get such a bang out of finding these flashes of attitudes in the way people look at the problem that they're trying to solve. Because the melting point of iron is so high, people have been estimating that the crucibles in India must have very high temperature, very high heat strength.

I was able to collect a lot of the shards, because when they finished firing, they'd break the sealed crucible open to get the ingot of steel. That's how they dealt with the problem of the steel being heated up and losing the carbon. I’ve tested these in my office. It was an interesting project, because it was one that was a little bit outside my understanding, and definitely outside my experience. And we found that, as you might imagine, because I used 50 of them, these were not particularly heat strong. But they figured out a way around it. That's very clever.

BALWIT: Just a different approach. These all sound like exciting experiences.

GOODWAY: Mostly happy ones. What I must say is that I don't dwell terribly much on the nasty bits. There were a few that I remember, but I feel I've had a very, very lucky life.

I wish I didn't have epilepsy. That's a pain, because you have to take God knows how many pills. But now that I'm back at Mass General, they're managing my care a great deal better than they did in Washington. That was probably one of the reasons, besides my family, that I wanted to come back and be here at MIT [and living in Kendall Square].

BALWIT: I imagine that it's a nice for you to be back in this kind of intellectual community.

GOODWAY: Yes. I've been very lucky. I mean, I walked into the Smithsonian, and I walked into a project at the first month. That was along with all the little things that went wrong. I was called upon because I knew how to use a microscope. I was called upon a lot to identify stuff that was not metal. But I used what I had learned as a kid by putting everything on that little microscope I had, and I know from whom to get the information I needed.

I ended up identifying an awful lot of fibers I wouldn't otherwise. I mean, you may not know the general classification into stem fibers and leaf fibers. And leaf fibers are much stiffer than stem fibers. Stem fibers are much more flexible. And you say, “What? To me, that sounds backwards”. But you think, “Well, the leaf has to be like an umbrella. It has to keep the spokes open.”

And I identified pigments – I identified anything that they brought to me. The thing I would try to do immediately was to make sure I wasn't thinking one thing out of a class, was it's some other class. That's the thing, if you make your identification too early. “Oh, I know it's that. It looks like that.” You have to be very careful of not making your decisions too early. You've got to feel. It's got to tell you, just as, in some way, that aluminum sample was telling me. But to this day, I can't figure out what, exactly, it was.

There was an awful lot of drudgery. But if you make it into, well, I know what that is, kind of attitude, you can go home after a day, which is basically drudgery, feeling that you've accomplished something. I think that's an attitude that I had. There were a few days which I couldn't possibly say that was fun. But most of them I could.

BALWIT: That's good.

GOODWAY: And then some days were just stunning. When I think of it, some people have gone through life and they're never had such a stunning day of discovery hitting you over the head!

I can't help but feel that that tour through the MFA that I told you about before [where Goodway met Bill Young, who helped her launch her career], the one that included the laboratory, was a godsend. I loved the Museum of Fine Arts.

If you see no other object [when you visit the MFA], go up the stairs, turn directly right and go in. One of the first objects you will encounter is [the bust of Prince] Ankhhaf. It is Old Kingdom. It's supposed to be a terribly, more or less, primitive pot. He looks human. It's a perfectly modeled human being. It is not one of these Late Kingdom-- It's not at all standardized. It looks like something that was modeled by a very skilled person that could be alive today.

I think that kind of experience has helped me in my attitude. The latest stuff doesn't have to be an improvement. It may be standardized. It may be made simple to produce. There are all kinds of possibilities that would change the history of, say, an object. Where do you put it? And people tend to put the better-made-looking object later. It has to have been [made later]--

BALWIT: They just assume, “They couldn't have done that then.”

GOODWAY: I was saying when we met earlier that my grandfather did a lot of work in genealogy. He'd just get on a train going somewhere, just randomly. He'd get off randomly, and he'd go to the library, wherever the records were, and see if he could turn up anybody that fit in the family, because we're so thick around here. We knew we [members of our family] were on the Mayflower because nobody ever forgets that. My cousin is named Howland. That's the same name as the ancestor [John Howland] that she descended from. He fell overboard. They obviously picked him up, or I wouldn't have a cousin!

Another ancestor worked for Queen Elizabeth. He had a mansion, which he sold. That's where they got the money for the ships. They chartered two ships. One was the Mayflower, and the other one was the Speedwell. But the contracts were pretty difficult to enforce, and particularly when you're at sea. The captain of the Speedwell said, “I've got to take it back before it sinks.” So they transferred all the people that were on the Speedwell onto the Mayflower, which was the reason why it was so heavily laden. There were more people on it than there should have been.

And then, of course, they were going to Virginia. That was supposedly a known quantity. But the captain of the Mayflower took them out around Cape Cod. And that water on the outside arm of the Cape is very nasty, which is the reason for the Cape Cod canal. It's weather, it's not distance. But apparently, he got them out into that kind of water, and then proposed that they landed closer, which they were happy to do. So they ended up in cold, nasty New England, of all places.

BALWIT: And here we are.

GOODWAY: And here we are. There are stories everywhere. That's one of the reasons that following the objects, it’s “OK, where do they fit into the story? How did they use it? How important was this to them? Was this a really important thing, or was it just nice?”

BALWIT: You have to take into account the entire context of the object. Just like you said when we spoke earlier, we don't know all the fundamental principles of the universe, but we still have to make things.

GOODWAY: That's right.

BALWIT: You still have to do work and try things out.

GOODWAY: Well, It's been delightful to talk to you.

BALWIT: It's been wonderful to have this opportunity.

In a second interview in 2018, Goodway spoke with MIT undergraduate Madeleine Kline about her childhood, the engineers in her family and their influence on her, and discovering her affinity for metallurgy while a student at MIT.

KLINE: I wanted to ask where you were born and where you grew up.

GOODWAY: Well, I was born in Boston, and I grew up there.

KLINE: Where in Boston?

GOODWAY: A part of Roslindale that was near Forest Hills. My paternal grandparents had a huge house. It was built back in the days when Jamaica Plain was [considered to be] out in the country, and this building, this house was built on top of a hill.

Then, eventually, of course, everybody had to have a little house. And the little houses began to encroach. And finally, after grandma died, the house was gotten rid of and it was torn down. Not only did they tear down the house, but they tore down the hill it was on. There are now, I'm told, three little houses.

KLINE: Oh, wow.

GOODWAY: It was halfway between where I lived and where I went to elementary school.

KLINE: So your grandparents were close by?

GOODWAY: Yes, grandma and grandpa were definitely close by.

KLINE: And they were your mother's parents?

GOODWAY: No, my father's.

KLINE: And where were your mother's parents?

GOODWAY: My mother's mother died. She was a Christian Science practitioner, so I was sent to Christian Science church, Sunday school. It's not routine, in that they made you think about the Bible and whether it was correct or not and that kind of thing. That puts you really out of sorts with the main line, and particularly the people who believe every word-- She pointed out things like there are two different versions of the creation of man in the Bible. That was the [approach taken by] the founder, Mary Baker Eddy. And of course, one of the things that she didn't point out was how absolutely silly the story of Adam and Eve is. A man produces a woman? That is nuts. It's absolutely nuts. So at any rate, my mother, I think, was very influenced by her mother, who died relatively young, but not before she made my grandfather promise not to marry again.

KLINE: Wow, that's awful.

GOODWAY: That's right. It was terrible. And he, being an upstanding Yankee, of course, not only did he observe that he did not remarry, he didn't even keep a little friend around.

KLINE: Was your father from a Christian Science background?

GOODWAY: Oh, heavens, no.

KLINE: No?

GOODWAY: Heavens, no. Grandpa Goodway was a Mason. Grandpa Goodway was a marvelously Christian man without ever mentioning it or really noticing how good he was. He just was a good man. Grandpa died, unfortunately, a little on the early side. Grandma was there. And if it wouldn't have been that, I don't know if I'd know anything with any degree of sanity whatsoever. It's amazing what happens in families.

KLINE: To be sure.

GOODWAY: But at any rate, I had been sick. And when I was six years old, I think my mother was still trying to believe that I really wasn't sick. In fact, she didn't believe that I was sick. And she said to my first-grade teacher, "Isn't it wonderful? Martha's finally putting on some weight." I must have been a skinny kid. And Miss Davis, having seen an awful lot of first graders in her career said, "That's not fat. That's water." My kidneys were failing.

KLINE: Oh, wow.

GOODWAY: Yes, exactly. And by the Christmas vacation of my first grade, my mother finally was thoroughly frightened, called a friend of hers, and who was the widow of a medical examiner. And this woman said, "Well, Vernon used to say that doctor so and so on Blue Hill Avenue was the best diagnostician in Boston." So off we went to see him. The only thing I remember about him was reaching across and picking up the phone. He was making an appointment for us. That was in the days when the operator answered and said, "Number, please?" No dialing or anything of that sort, no do-it-yourself.

And off we went immediately in town to Longwood Avenue. The doctor looked me over. I thought this was a short exam. He walked across the room, came back with a blanket, wrapped me up, carried me across Longwood Avenue and put me in Children's Hospital. There was no waiting. And then I spent more than a year in Children's Hospital.

KLINE: Oh, my gosh.

GOODWAY: Well, finally, both kidneys quit. But Children's Hospital had a machine, a dialysis machine. So my doctor-in-chief went to the committee in charge of this marvelous machine and said I was in desperate need of it. According to him, they spent only three minutes conferring about this. He came back, and said, "No." They were loading the machine to a hospital in New York.

KLINE: So what did they do?

GOODWAY: They wrapped me in hot blankets. I came just for a moment into consciousness during this process at some point. And there was this card at the end of the bed, and an old-fashioned wash-boiler, and my mother on one side, my special nurse on the other wringing out a blanket of hot water. They would wrap me up and sweat out-- It completely confused the control of my temperature, but it kept me alive. And it wasn't until I was 16 at the end of a particularly hot summer when I suddenly came out in this marvelously cooling sweat. I thought, “Oh, isn't this wonderful?” And each summer, that would happen a little bit earlier until things begin began to be normal.

KLINE: With your temperature regulation?

GOODWAY: Yes.

KLINE: So you have functioning kidneys now?

GOODWAY: Yes, they healed somehow. But of course, they take an awfully long time to heal. It's not like breaking a leg.

KLINE: Did you find out what caused the damage?

GOODWAY: No. Nobody has made the slightest sensible suggestion as to why that should have happened. I don't know. So my whole childhood really was a matter of dealing with not being as strong as other people, the other kids. I didn't play games; I couldn't. When I was 10 years old, I was given a tiny little light microscope [POINTS TO IT]. It's very simple, but elegant looking, I think.

KLINE: It’s in great condition. I'm surprised!

GOODWAY: Oh, yes. I took very good care of it because it was another world. The other kids were much too busy to be bothered with anything like this. So I had an awful lot of what things look like microscopically, and stored them in my head – which, when I got to the Smithsonian, turned out very useful. I was the only one that knew anything in that laboratory about using an optical microscope, including the director.

KLINE: Did you have brothers and sisters growing up?

GOODWAY: No. When I was maybe between one and two, my mother collapsed in the street, actually. Her spine let go. And then fortunately, in Boston, and a doctor named William A. Rogers was a specialist in mending bones and such. He operated on my great grandfather, so he was going to operate on my mother. And he did a spinal fusion. They put a metal reinforcement in. But then nobody did anything. So he took some bone from the lesser of the two bones in the lower leg and used that to reinforce her back. He fused five vertebrae and six discs. And nobody knew whether it was going to take. She was in a cast from her pits to her hips. And it was, of course, plaster. It wasn't anything light or anything like that. She was stuck in it for four months, and she was told she was not to have any more children. And she was stuck with a female [child].

KLINE: You think she was disappointed that she only had a daughter?

GOODWAY: Oh, yes. The environment was such that you couldn't avoid it.

But dad was an engineer. And how did he become an engineer? Well, when hewas seven years old, they were living in Portland – before they came to Boston.

KLINE: In Maine, or--

GOODWAY: Yes. But there was a young man rooming with him. Single persons didn't have their own apartments in those days. The young man had a crystal radio. In those days, this was before speakers, so you had to have a headset. My father was so entranced with this, interested, that the young man went out and bought a second headset so he could listen in. One night, my father told me, he tapped on the door and peeped in. “Would it be OK to come listen to the radio?”

And the man, instead of taking his headset off, just used hand signals: Come in. He pointed to the other headset, and they sat and spent the evening listening to the last transmissions from the Titanic.

I think my father's future was set at that point at age seven. He grew up with radio. He quit high school – he walked out of Mechanic Arts High School. He walked across the street, joined the telephone company. He had a workbench. He had a work group put under him, including Maurice Tobin, who later became governor of Massachusetts. [Tobin was also a mayor of Boston and U.S. Secretary of Labor.] People realized he was not dumb. He was a self-taught engineer.

My memory of him distinctly is of his sitting of an evening with a book he was studying. I grew up during the Great Depression, and we didn't have anything. You saved everything. And when finally, mother couldn't mend things, there was nothing to attach darning to, the rag man came by. And the rag man had a horse and wagon. And he would cry out, “Rags. You want rags?” That's what happened.

Anyway, my father had a radio shop. And a man who, his buddy, who eventually became an uncle, they ran this shop. In those days, you made a radio to suit people's desires. They were all handmade. And finally, things got really difficult. A dear friend of the family, who was really what nowadays we would say a career advisor or something like that, suggested-- There was this company that was formed, a bunch of engineers including Vannevar Bush [MIT Professor of Electrical Engineering, then Dean of the School of Engineering and Vice President of the Institute; Bush had headed the Office of Scientific Research and Development during WWII; also known for his work on analog computers, developing memex and a device for assisting surveyors]. Now it's, of course, Raytheon. Dad went there to interview, and he got a job as a draftsman.

Now it's all done on computer, but when I was a student at MIT, drafting was one of the courses I had to take. And drawing up the big final-- It was a huge drawing in India ink. I can remember working on it the night before, as we all were, in the big drafting rooms, which is also where I took the SATs, and one of the men upset his bottle of India ink all over his. And I heard words that no young lady had ever heard before. Now, of course, we hear it. It's in print and so forth. I'm still not used to it, that kind of language!

Anyhow, it was a learning experience. But dad got a job as a draftsman. He went to Raytheon. The first morning he was there, he was giving a sketch of a circuit that had not been fully designed. But they said, “You can get started in drawing this up.” They came back at noon and discovered he had completed the design of the circuit, at which point they made him a junior engineer.

It took him four hours, so it was clear that he had done a very good job of training himself. And it was a good thing for me, because as an archaeometallurgist, there was nobody to teach me. I had to teach myself. But it didn't bother me.

KLINE: And you---

GOODWAY: I was very interested in science, although the science and math teaching in Roslindale High School was abysmal. I must have flunked those. I don't know how I got into MIT. I know my mother had arranged for take me out to lunch in the morning and the afternoon on the SATs. Then she got me in the car and we went God-knows-where. But it was too far away from me to walk back. And then she dawdled over the menu and so forth. So the upshot of that was that I was 25 minutes late for the English exam.

KLINE: For the SAT English exam? Wow.

GOODWAY: But my English teacher [mentioned in the first half of this oral history] told my mother, “Martha could not have done better.” I think that was one of the reasons I managed to get into MIT. So I had a very funny preparation.

But getting back to my dad, we had a lathe in the basement, and he taught me how to use it. And there was a forge out back of the garage. Nobody spoke about that. Who knows what the fire department would have had to say about it! But things were not quite so tight as they are now.

I used to have to crank to produce the blast. And I learned right at the start, keep the steel in the cauterizing part of the fire and not in the oxidizing part or you will lose the carbon. Did that turn out to be a useful thing? Yes, because one of the papers I wrote later, the long one, was making sense of harpsichord wire at the top [discussed earlier in this oral history]. Everybody knew it was iron containing something, but they said, “Well, you can calculate it very simply from the length, and the key is how strong the wire has to be. A very simple calculation. And everybody said, “Well, it has to be very, very, very thin, very strong. It must be. It had to be steel.” Well, there wasn't any detectable carbon in it. That was the result from United States Steel.

The Smithsonian doesn't have a lot of the equipment they need, so we sell the task and people get interested in it – they're willing to help the Smithsonian. And I shamelessly use as many of these people as I possibly can because it was good for me, because as the only metallurgist at the Smithsonian, I had to have a check on whether I understood properly. You can get off in left field rather easily, as you know. So that kept me honest.

KLINE: So arriving at MIT, it sounds like you had, well, not a good math and science preparation, but good preparation in how to think about problems.

GOODWAY: I had a good example from my dad.

It was also important that the war came along. Grandpa Goodway gave the family boat to the Coast Guard, and young folk who had no idea of the sense of danger, supplies, and all the rest that went with the seventh of December [the Japanese attack on Pearl Harbor] just don't grasp the seriousness-- It was amazing.

People who could afford it would do a season ticket to the Boston Symphony. It was conducted by Serge Koussevitzky at the time. And the first concert, the first Boston Symphony concert after the seventh, it must have been around the 12th or 13th, he walked on the stage. I've forgotten what was scheduled, but they said absolutely nothing about any change in the program. He just walked out there, raised his baton, and they played The Stars and Stripes Forever. That's not what the Boston Symphony usually plays, so that was how it [Pearl Harbor] hit everybody.

And dad, being at Raytheon, certainly couldn't say anything [about his work]. He was working seven days a week and had terrible migraines. When the war was over, it was amazing: all the sudden, he could talk. And there was this word, "radar." Oh. [As I told Natasha Balwit], his boss was Percy Spencer. And Percy Spencer had this funny idea that you could cook with a radar. He chose four of his engineers to see if this idea could be worked out, and my father was one of them.

He'd come home every night and over dinner would discuss what had happened at work. He finally could talk. And, of course, there's more problems than successes in engineering, as we know. I heard of this night after night after night. "Well, that went wrong, so we had to figure out what to do about that. and we thought maybe…" Et cetera.

What amused me the most was the fact that not one of those four men his team could cook. So one evening, dad came home with a story: They'd gone out to eat at Howard Johnson's and bought two frozen apple pies. This is when frozen food was new, really new. So when Percy came by on his way out, they said, "Look. We've got these apple pies here. Let's put one on [the magnetron]. You've got to imagine how it was set up at the time. There was a magnetron on the bench, something to direct the energy upward, and then a cake rack across the top. That was it. So they put the frozen pie on the cake rack. Percy wasn't very tall, and he had bushy eyebrows. They had a small stepstool, so he climbed up to see what was going on up there. And of course, they turned on the magnetron. They very early learned that they had more power than they needed by a long shot. But at that time, they weren't there yet. So they turned this thing on. And an apple pie has two layers of crust?

KLINE: Yep.

GOODWAY: OK, well, they turned this thing on, and it blew up. t was all over them, bits and pieces of apple pie! My father said he had a couple of bad seconds before he realized that Percy was OK, hadn't been burned. But then they had to clean his eyebrows up before he was sent home. As a child, I loved that description of removing bits of apple pie from his bushy eyebrows.

But most of the time with dad, it was what went wrong that day and what they were trying to do to make it right.

KLINE: An example to learn from.

GOODWAY: This was a better training for engineering than I ever got at MIT. The assumption at MIT is that it's going to work, right?

KLINE: Right.

Could you talk a little bit about your experience at MIT, for example, some of the most notable classes or your experiences with professors?

GOODWAY: Mother insisted that we couldn't afford the dormitory or my living close, so I took the T, walked a mile to the bus, bus to Forest Hills, into the connection with the Red Line.

It was difficult, in the sense that there were these kids with these underdeveloped brains and the G.I.s, who, presumably, had a lot in their favor, the experience of being in the service, and disciplined and all the rest of it. So I don't know how I got there in the first place. I was so exhausted that when the little order form came from the Institute for my next year, I put down that I would go to the women's dormitory on Bay State Road [in Boston].

KLINE: Yes.

GOODWAY: And Mrs. McCormick [Katherine Dexter McCormick, class of 1904; a suffragette and reformer, and the benefactor of McCormick Hall, a dormitory for women that gave female students a place to live on campus for the first time in 1963] would give us money for taxis for when the weather was dreadful. She was a wonderful woman. You know what she funded, don't you?

KLINE: I'm not sure.

GOODWAY: Well, her husband was ill. She tried as much as possible to use the money that they had to fund research that might help him, and then he passed away. People knew she would invest in medical research. And there was one line of medical research that nobody would fund, none of the private foundations, none of the public monies-- She funded the [birth control] pill. Anyway, Mrs. McCormick saw to it that we weren't out in the worst of weather.

And Shelia Widnall [SB AeroAstro 1960, SM AeroAsetro 1961 and SCD AeroAstro 1964; Institute Professor; Secretary of the Air Force 1993-1997 – the first woman to hold that office and the first woman to lead a branch of the U.S. military] was in the dormitory at the time. She became, of course, a professor of aeronautics, and eventually Secretary of the Air Force. I also knew the first black person to be at Harvard: Clifford Alexander [Secretary of the Army 1997-1981, the first African American to hold that position]. I knew him. He eventually became secretary of the Air Force, then Sheila was.

He called me up one day and said, “Would you like to come to lunch on Saturday?” I said, yes, not quite knowing what was afoot. We were upstairs in a house, in what was actually probably the master bedroom. It was a long room with lovely windows and this long table set up. And the guest of honor was [then counsel to the NAACP] Thurgood Marshall. He was in the midst of arguing a case before the Supreme Court. He told us how they planned, what the arguments had been last week, and how they were going to open the arguments next week. My God, an amazing experience. MIT is a way of opening you up to other institutions.

But now, of course, Harvard's coming down Broadway, and MIT is going up, and interesting things are happening. And I'm glad to see that. It's the way it should be.

KLINE: What was MIT like for you?

GOODWAY: I wanted to get out of the School of Science and into the School of Engineering. I did not want to pass any of the courses that I was in, so I sat out the finals. I handed in empty blue books, and of course, got booted out. Well, you're supposed to do something useful if you've been booted out and you want to apply, re-enter. Well, all I did was sleep. I was exhausted, because I was not strong, as strong as I was going to get, until I was 30.

So when I went back [re-entered MIT], one of the first things I took was Metallurgy for Engineers. Yay. Not only was the school of engineering the right place, metallurgy was the right course. And this lab, in order to accommodate as many students, G.I.’s, as possible, all of the three-hour labs were two hours long. They hadn't shortened the work, of course, being MIT, as you know, so you got to the lab as fast as you could and got going!

A G.I. actually chose me as a partner, and it happened that I could make the equipment work. He sat there with the lab notebook on his lap, and I would sing out the numbers, and he would write them down. And I would say, "Now hold the wires in this order," and he would do exactly what I asked. Then, after this frantic two hours, he would invite me out for coffee.

Well, that was such a treat because my parents believed that I was too young to drink coffee. It sounds crazy, but it's true. And then over coffee, it's a wonder I paid any attention. It was just thrilling. He would tell me what I'd done, because he had been watching all of this happening, and running things. It took me two decades before I realized, "Oh, my God, Martha. You were a woman giving dictation to a man? Unheard of!" But we had the only consistently good lab notebooks that anybody could find, and mine got handed around all over. I finally lost track of it. But it was an interesting experience working with him.

KLINE: What did he go on to do?

GOODWAY: I haven't the slightest idea. Anyway, metallurgy made sense to me. I've just had a feeling for all of this kind of thing. Thank goodness for metallurgy – it's pretty essential.

Anyhow, the rules were that the professor could give us five quizzes. He dropped the lowest grade, and that would be what we would get. Well, I was doing awfully well in that course, and I was awfully close to the next grad above. And I thought, well, I'll take the fifth quiz. So he graded all five. He couldn't flunk me – I was in really such a good, strong position.

He was the one that-- On the day I graduated, I was walking down the steps at 77 Mass Avenue and he was heading up. He was heading towards me. We stopped in the middle of those steps and he said to me rather angrily, "I don't believe women belong at MIT." Well, here I had my degree literally in hand. Most of the professors at MIT were smart enough not to say it, regardless of what they felt. That was an interesting experience.

KLINE: And being one of just 19 women in your class--

GOODWAY: Well, women would come, try it for a year, maybe a term, and leave.

One of my dear friends actually left, a brilliant woman. She finally found herself. She discovered Classics, and then, in about two years, she got her PhD and became a professor of Classics. So we had people like that. They were still finding themselves and giving MIT a try.

My roommate at the dormitory was like many other people at MIT, was sent to MIT to learn how to run the family business. There were two DuPonts, and one was in metallurgy in my year. Then there was one guy, a class ahead of us – everybody thought he's going to be the eventual president. He was taking Course 15 [Sloan School of Management], of course.

My roommate came to MIT for exactly that reason, her family business. Her family ran a grinding wheel factory in Bombay, and one year they said, “Well, we have a girl coming from India. Who will take her as a roommate?” Well, she was a spark plug of a person. It was great. It was absolutely marvelous.

Living in India, she had never seen the snow. But they had a pseudo English education, so they knew all about snow angels, making snow angels. Well, one morning, I heard this cry of enthusiasm. It had snowed, and out she dashes. And I jumped out of bed and followed her down the stairs. By the time I got to the front door – this was on Bay State Road – she was lying on the ground in the little front yard, making a snow angel in her pajamas.

KLINE: What was her name?

GOODWAY: Almitra Sidhwa [SB General Engineering ’58 and SM Materials Science and Engineering ’59; member of India’s Supreme Court Committee for Solid Waste Management]. Now her married name is Patel. We're still great friends, as you can imagine. I feel very lucky about the women that turned up at MIT at the time, because even if they stayed only a year or a term, they were interesting women to have made that choice. Sometimes they were absolutely baffled because they just simply didn't have the-- I felt I had an advantage: I came from a family of engineers.

KLINE: Did you experience discrimination in your career, as a woman?

GOODWAY: At the Smithsonian, I made a really good friend. At one point, I had published several papers, and my friend got a promotion to the next GS level on the basis of publishing one paper. So I go to my director and tell him, “This is my third paper in *Science*. Don't you think I should have-- I think it was about five grades between us. “Don't you think I deserve a promotion from a GS11 to a GS12?” “Oh, no. You don't have a PhD.” Well, how was I going to get a PhD in what I did? But men just cannot bring themselves to do this. That's why I feel it it's important for women to be in boss positions, just as the man who I worked with on the aluminum paper. His boss was a woman. She was in a difficult position because both she and her husband were in the field, and they had to find a way of moving together. It's very, very difficult. I hope it's getting easier.

KLINE: What about before you started at the Smithsonian?

GOODWAY: One of the jobs I had before I went to the Smithsonian – because it took a while, it took 12 years to get to the Smithsonian – was this small company in a one-story building where the [MIT] medical department is now. We had two rather important contracts. We were beginning to get rockets that could escape the atmosphere. People forget there was a time like that. Then I was on the other contract, which was essentially working out the difference between an atom bomb exploding in the air and exploding underground. I was scheduled to go out to the Bikini [atoll] and be involved in the explosion in the air, but the Marines would not let me or any woman on their island.

The Air Force ran the Nevada test site underground. Well, they didn't want a woman on their test site. But I was told that the company threatened nonperformance of contract, so I got underground! I am a genuine hard hat engineer! Yay, I got something out of it. But it was a difficult time. Somebody had to give, because the test bench radio was approaching and this had to get done. While the other half of this little company had on its team was Riccardo Giacconi [Italian Nobel Prize-winning astrophysicist who laid the foundations of X-ray astronomy]. One day, I'm working in my little lab. I remember vividly, I was cleaning those, scraping the bell jars, nasty jars, and I hear steps coming down the hallway. And I recognized them. And then his voice as he passed my open door, calling down the other end of the hallway, he said, "They found it." What was it? "They found X-rays. They found X-rays."

Well, they got up far enough out of the atmosphere – the marvelously protected atmosphere – to detect the radiation in outer space. And eventually, Riccardo got his Nobel Prize. It's not everybody's good luck to be, if not working on a Nobel Prize project, working next door to it.

KLINE: That's amazing.

I wanted to ask you about something a little more mundane: your brass rat [MIT class ring], which is probably one of the best kept brass rats!

GOODWAY: Well, it should be. I'm a metallurgist after all, right? OK. What is used to harden a yellow brass rat?

KLINE: I don't know.

GOODWAY: It's usually copper. It's like sterling silver, hardened that way. Well, there's another way. And I looked at the guys that were wearing brass rats. And I was thinking, “Boy, they don't wear well.” None of the corners were left. So I decided to get mine in white gold. You can tell it's gold – it's heavy. Well, they weren't used to doing that. But at any rate, you can see the three pieces of wax that went into the mold, so I use that as a teaching example. You see what good condition it's in? There is wear, but there's not as much. Do you know what makes it white? It's nickel. Nickel has a very high tinting power, so you don't have to lower the level of gold in order to get this color. I didn't realize, of course, as a kid that as time goes on, it looks better. So that's the story behind the choice I made.

Tell me, what course are you in?

KLINE: I'm in biology and chemistry.

GOODWAY: You can combine those now?

KLINE: Yes, it's a joint major.

GOODWAY: That's great.

KLINE: I'm really happy with it so far.

GOODWAY: And what are you working on now?

KLINE: In my research? Well, I'm about to go back to the lab. It's a synthetic biology lab, so we're using paper-based, cell-free diagnostic technology that can detect specific RNA transcripts based on, in this case, a human stool sample that can correspond to specific inflammatory signals.

GOODWAY: Good stuff.

KLINE: I love it. I'm so happy with it.

GOODWAY: That's the way it should be.

KLINE: Right. Well, I really appreciate your speaking with me.

GOODWAY: It’s been my pleasure.