INTERVIEWER: First of all, this is the 150th anniversary celebration interview with John, it's --?

OCHSENDORF: Ochsendorf, like o- x- e- n.

INTERVIEWER: So tell me where you were born and where you grew up.

OCHSENDORF: I was born in Columbus, Ohio. My parents were both from Ohio. And when my parents were about 20- years- old they decided to live a simpler life. And they basically moved to rural West Virginia as a way of going back to the land. So I grew up in West Virginia from a young age of about five, and went through high school in Elkins, West Virginia, a small town in the middle of the state of about 7,000 people. It was an absolutely beautiful place. And we grew up in a way that wasn't very usual in the United States in the 1980s. We had no telephone and no television. You know my parents were really interested in living a simpler life, and reading books, and growing around food. And it was just a phenomenal way to grow up. And I grew up as one of six children. So I had five brothers and sisters. And I often said that my parents had children because they were a good source of labor for weeding in the garden, and chopping firewood, and everything. So it was an absolutely fantastic place to grow up in the small town in the country with really devoted teachers and a wonderful community.

INTERVIEWER: Do you think that the sort of non-technological upbringing has impacted your work in any way?

OCHSENDORF: It has. We of course had technology all around us. And we used technology in lots of ways. But it wasn't maybe technology that most late 20th century American households had. So once a year we would borrow a cider press from friends who would put it on our front porch. And we would make apple cider from apples. So it's a bit like growing up on a farm. So you're surrounded by technology, but maybe not the telephone and things that were so active in other Americans' lives in the 1980s. But I would say yes, it is kind of strange for someone to grow up in a house with not a lot of technology, to become a faculty member at MIT. But I became an engineer, in part, because I was good at math and I liked problem solving. But I think the childhood has influenced me in terms of how I bias technologies. That is, I give value to technologies that are maybe simpler or local. And I think that does come out in my research and my work.

INTERVIEWER: Do you have a TV now?

OCHSENDORF: We do. It's a little bit of a funny story. And it's very recent because my wife's family offered us a television for Christmas this year, and I declined. I said, no thank you. We don't really need a television. And then a few days-- a few weeks-- later a delivery truck showed up and said, oh we have a television to deliver. So I was overruled. But the truth is I really like sports. I like to watch sports. I'm particularly interested in soccer. So I follow European soccer teams.

INTERVIEWER: My husband too.

OCHSENDORF: Oh very good. And when I started at MIT, I set my start date around the World Cup in 2002. I had just finished my PhD and I delayed my start so that I could have a full month of uninterrupted soccer watching with my good friends. So, yes. Soccer is very important to me.

INTERVIEWER: And you attended Elkins High School, which is a big deal. They're quite well-known.

OCHSENDORF: Well in the area. I mean it's a public high school. I mean, when I was there-- I graduated in 1992-- it didn't have AP classes, for example. And maybe half the kids go to college. Generally in West Virginia they're pretty high illiteracy rates. And I had friends who were very talented, very bright kids, who growing up never made it to college. In part because of their socioeconomic backgrounds, or their educational opportunities. But from Elkins High School I got a very good education. And I ended up going to Cornell University as an undergraduate. But in a certain way, as a fluke. A friend of mine had an application he hadn't filled out. It was due the next day. I said, could I fill it out? So it wasn't the hyper-intense world that, you know, my MIT undergraduates are in today where they're thinking about where they're going to apply from age eight. And, you know, in some ways that was nice not to have that pressure. But I also got lucky. I'm very aware that where I grew up, I could have ended up on a lot of other paths in life. And not all of them led to being on the MIT faculty. Which has been a great joy.

INTERVIEWER: Why did you pick Cornell?

OCHSENDORF: I was really choosing between Cornell and Ohio State, where my father had gone. And I knew it was a good school. I was accepted in the engineering school. I hadn't even visited by the time I accepted. My mother had gone to Cornell, to Ithaca, when she was young. And she'd gone to Cornell football games. So she had good memories of it. And I thought hey, sounds great. There was no web at the time. So I couldn't look at images online or read blogs about the place. But I did see some pictures, and it looked beautiful. And for me, growing up in a town of 7,000, Ithaca is a town of about 25,000. So it was a little bit of a step. But it wasn't like moving to Manhattan or moving to Columbus. And as it happened, Cornell was a perfect stepping- stone to the world. Because my friends were from all over the world. You know, my friend's from Manhattan thought Ithaca was a tiny little town in the middle of nowhere. But coming from Elkins, I was in this metropolis. And then I could go to Manhattan on the weekends and slowly, basically changed from being pretty much a country boy into someone who felt comfortable in big cities of the world.

INTERVIEWER: Why did you decide you wanted to study structural engineering?

OCHSENDORF: In my first semester at Cornell, I knew I wanted to be a civil and environmental engineer. At least I chose that, in part, because I wanted to save the earth. I knew we had environmental issues that were a concern. And I thought as an engineer I could work on those. And in the very first week, I grabbed a senior who spoke to us about civil engineering at Cornell. And I said, what should I do? What's a good thing for a freshman to do? He said, take a class with Mary Sansalone, that was a very special professor. And she taught an introductory structures class. And I took that class and it just changed the way I saw the world. When you study structures, you're studying the mechanics of everything from skyscrapers to trees-- why the branches of trees are shaped the way they are. So all of a sudden it was like, I often said I went to college to understand the world around me. And you can do that in a lot of different ways. You can study economics. You can study anthropology. In studying structural engineering, I really felt that I could look around me and I could see the world with a new eye, how things worked, and why they were shaped the way they did, and why they use the materials they did. And so that was absolutely thrilling. So that happened in my very first semester. And some of the teaching, let's say innovation that she developed at Cornell, I've been using in my classes here at MIT. Such as case studies: you know learning from case studies of exceptional structures or building models and comparing theory to experiments. And I'm very pleased that some of my students' videos of our testing have made it onto YouTube for example. So if you go to YouTube and type in MIT column testing or something, you can find a video of some of experiments we do in our classes, followed by pretty exciting applause. So there's a very much an engaged learning that I got from that first semester at Cornell. So I fell in love with structures and she mentored me throughout my undergraduate and PhD, and still does today. So it is really because of one person. That's the easy answer.

INTERVIEWER: As you went through Cornell, they sort of didn't know what to do with you. Did they?

OCHSENDORF: Well something happened in my sophomore year that was a vital, say crossroads, in my life. I was taking all these engineering classes and I was solving problems. At MIT, we called them problem sets-- p-sets. So I'm solving problems week after week after week. And pretty much all the problems had one answer. So I'd solve a problem. I put a box around it. And there, I'd gotten the answer. I could move on. Well after two years of this I started to get disillusioned because I knew the world wasn't really like that. And I was missing out on-- you know, I grew up reading books-- I was missing out on so many other aspects of the world, culture, and history, and in a good liberal arts education. You're taking surveys in other areas. And so I was taking a class that has, as an activity, an archaeological dig outside of Ithaca, looking for remains of a Native American settlement from 3,000 years earlier.

And so I spent a Saturday on an archaeological dig. And I dug in the mud, a test pit, all day long. I didn't find a single thing. I didn't find a bead of anything at all. And yet it was just the most thrilling day of my life. And I think the idea that I could have found, or could find an artifact that was a direct connection to a person who was on that spot thousands of years earlier was so thrilling. And so I went to my advisor's office the next day. And I said you know, I really appreciate your help, but I'm transferring to archaeology because I think that's really what I was meant to do. And she was an absolutely exceptional advisor. And she said that is a great idea. She said, do archaeology, but don't leave engineering. So she helped me design my own major that combined structural engineering-- the study of structures, and buildings, and bridges, and structural mechanics-- with archaeology-- the study of human history through physical artifacts. And so for the remainder of my time at Cornell, I was really combining those two fields. And you're right. I was a bit of an oddball. But it meant that I was living exactly, or bridging this area that the writer, C.P. Snow has called the two cultures, which are the sciences and the humanities.

And so it was an exceptional undergraduate experience. And in particular-- just go into a little more detail-- I'd never traveled abroad. And I decided to study abroad. So I spent a semester in Australia. And while I was studying engineering at the University of Sydney, I was also studying archaeology. So I was taking classes in classical antiquities. I took a class in witchcraft and magic in classical antiquities. It was basically an ancient religions class. At the same time I was taking fluid dynamics. And my engineering classmates could not believe that I was studying what they called witchcraft, you know classical religions. But I was very happy. I was very happy exploring these. And when I came back to Cornell, midway through my junior year, my advisor helped me find a project which became a research project, a thesis, which was the study of the history and technology of Inca suspension bridges in South America. So that was a perfect way of combining my engineering knowledge-- granted at an undergraduate level-- with my love for archaeology and my interest in history. And it turned out that this topic, to me, that was immediately fascinating, it had scarcely been studied. So I would find books on the Inca technology or the Inca Empire, which thrived between about 1300 and 1530 in South America, centered in what is now Cuzco. And they wrote about the Inca bridges. Archaeologists wrote sentences like "the Inca built magnificent suspension bridges," period. And then wouldn't elaborate in any way. And it turned out that there was an area-- and as I'm going on in my career I found other similar areas-- where technologists, like engineers, typically haven't been very interested in our history. And archaeologists haven't particularly been interested in works of engineering, or haven't necessarily had the skills with the tools to ask the right questions about this work. So pretty much at the age of 19 or 20, with my advisor's help, I begin to create a discipline of the study of ancient structures as an engineer with an interest in archaeology. And that really was laying the foundation for the work I've done over the last 15 years.

INTERVIEWER: What was it about the Inca suspension bridges that most fascinated you?

OCHSENDORF: Well, one of the bridges still survives today in a remote area of Peru. And I think what I was so excited about, more than anything, was the notion of appropriate technology. They were deep, deep canyons, very wide with rushing rivers underneath. And building a bridge across these wide canyons was not an easy thing to do. And I quickly learned that when the Spanish arrived-- they conquered the Inca Empire in 1532-- for the next 300 years the Spanish tried to build bridges over these canyons with leading European technology at the time. And they failed. In order to build an arch across such a wide canyon, you need to first build a wooden form-work, or centering, to support the stones until the keystone is in place. So they spent the equivalent of millions of dollars and hundreds, or even thousands of lives trying to import European technology to this context. And the Inca had developed a solution that was very appropriate-- use local materials, span long distances. They were the longest bridges in the world at the time. And they survived for centuries after the fall of the Inca Empire. And so, in short, it kind of turned everything on its head that I'd been taught. I was taught that kind of European tradition of structural engineering, which of course, has tremendous accomplishments. But it was an amazing moment to see a technological encounter between Spain and the Inca Empire, in seeing that these bridges were exceptional works of engineering, and that they had survived for centuries. And that I could still go and walk over one of them today was quite thrilling.

INTERVIEWER: Good story about arrogance.

OCHSENDORF: I think so. And you know, you might expect that then the Spanish saw the Inca bridges, went back to Europe, told everybody about them, and then the suspension bridges were built in Europe. But it wasn't really like that. It was another several hundred years. The first major suspension bridges weren't built in Europe until the early 1800s. And therefore it was basically an independent invention. So the conquistadors and the chroniclers, who wrote about the Inca Empire, described these bridges in tremendous detail. And that was a great primary source material for me in studying the technology of the bridges. But nobody said, hey maybe we should try this here. So it's just fascinating.

INTERVIEWER: In your experience of putting together sort of your own it major by combining what people might think of as disparate interests, is there a lesson in there for students?

OCHSENDORF: There's absolutely a lesson. I try to say to incoming freshmen, as often as I can, give them some basic guidelines about how to succeed in college. And I really think inventing your own program is key. Because, let's say, for example, that you love physics and you love music. Why not try to combine those two? Why not try to create your own path in life? And I really do feel that there are certain areas-- both of research and of just general academic study-- that are so well trod that it's very difficult to make innovations in some areas.

Let me just hypothesize for a minute. There's a certain field that's plowing very deeply into its knowledge. And then there's another field over here that's plowing very deeply into its knowledge. Well there simply must be deep and interesting areas in between the two. And so I just think some of the most exciting work going on today is interdisciplinary, and people who have skills from two different fields, who combine them to solve problems in new ways. And I think for MIT, students who can harness this, or who can bring their skills from different fields, they're the ones who are going to create breakthroughs in the future. And so I think there are absolutely lessons in this. And I do think that MIT is a place where we don't really have boundaries between disciplines. And we generally do pursue good problems wherever they lead us. And I would say that I found that here, more than any other university I've studied at. It's not only possible but it's encouraged to combine different fields. So that's been something that I've really enjoyed. And it's been exciting about being at MIT.

But I certainly try to encourage it in my advisees. It's simply, it worked for me, right? So if I had plowed deeply into one area, I would have been one of 400 people with a PhD in a specific area. Whereas my strategy is a little extreme. And I often tell students that what I did was I intentionally chose subjects that could never ever lead to a job. No one is asking for an Inca suspension bridge specialist when you come out of undergraduate. But I just simply studied things that I was fascinated by and in love with. And I figured it would work out. And I was able to continue that through my graduate education, and now on the faculty. Well hey, it led to a job eventually. So I do think it's important that students should let's say, to put it a bit poetically the way Joseph Campbell says, to follow your bliss. Find what it is that you really love and pursue that path.

INTERVIEWER: So they call people like you silo breakers.

OCHSENDORF: I didn't know that, but okay.

INTERVIEWER: Because traditionally, in the academic model all the departments are separate.

OCHSENDORF: Yes. It doesn't come without risks. That is, if you bridge different disciplines, you need people in each discipline to say that you're important and you're doing significant research and significant work in your area. Or if you're going to try to create a new field, you need at least enough other people in that new field to say that what you're doing is important and interesting. Yes okay, if you break out of the silos then it's important that you're not alone in the field somewhere. You need to have someone who can recognize the value of your work. So, yeah. There is a certain risk to it.

INTERVIEWER: So what made you pick Princeton? And what made you pick civil and environmental engineering?

OCHSENDORF: Well your questions are fantastic. At the end of my undergraduate, I'd been working on the Inca bridges. I presented a research paper at Berkeley as a senior. And I got a great response. And the professor came up to me, who is an archaeologist specializing in the history and technology of materials. And her name was Heather Lechtman. She's a very distinguished professor at MIT. This is what we do at MIT. Come to MIT and do archaeology. And I looked carefully at graduate programs in archaeology. And I decided that I had made a contribution as an undergraduate because I was an engineer and I can bring technical skills to archaeology. And I could make a greater contribution if I stayed in engineering. And let me put another way. The archaeologists welcomed me with open arms to archaeology. The engineers wondered what in the world an archaeologist could possibly offer engineering. And so I basically felt like engineering needed me more than archaeology needed me. And so I decided to pursue graduate school in structural engineering and structural mechanics. And my philosophy about graduate school-- and again what I say to my students today is-- you should find someone who inspires you or someone who you really want to learn from. And so I think of it as kneeling at the feet of a master, and just trying to learn from someone who's at the top of their field. So I went to Princeton for one reason. And it was a tremendous professor name David Billington, who is a historian-- he's structural engineer-- but he's a historian who has really created the study of the history of our field and identified who the great designers were.

And so just as an example, imagine if you were to study literature or music without studying great works of literature or great works of music. Architecture is the same way. If you said to an architect, name your five favorite architects. They would struggle. And they would struggle because they would have 50 in mind and they'd have to narrow it down to five. If you said to a structural engineer, name your five favorite structural engineers. They would struggle. And they would struggle because they could not even name five, much less five favorite or argue you as to why. And yet, our field has a tremendous history of really remarkable people. Gustave Eiffel, who was a great bridge builder in France, who eventually built the Eiffel Tower which immortalized his name. John Roebling, the suspension bridge builder in the United States who built the Brooklyn Bridge, designed the Brooklyn Bridge. These are heroes and their works are worthy of academic study, rigorous study. Why is the Brooklyn Bridge a great bridge? And as engineers, we don't learn that history. So David Billington at Princeton, is really one of the only leading professors in the world who, in the structural engineering department, has made the study of history a central pillar of the academic program. And I think you get better engineers out of it. So I went to work with him for two years. I was his teaching assistant. And it was life changing.

INTERVIEWER: And after the Master's you decided to go abroad.

OCHSENDORF: Yes. I got a fellowship, a National Science Foundation Fellowship which gave me three years of funding to go anywhere in the world. And I often encourage my students to apply for this. Because it basically gives you complete freedom in your PhD and what a gift. I mean, what a gift from the US government, to endow these fellowships and to let young scientists and engineers pursue their passions in their topic. So that freedom is something that I'm really grateful for. And I decided to go abroad. I looked around and I decided to go to Cambridge University. And at Cambridge, again, following this model-- the Billington model-- I found a very special professor named Jacques Heyman, who was a structural engineer, who had been chief engineer of Westminster Abbey and a number of other major cathedrals around England. And basically he revolutionized our understanding of the mechanics of old stone buildings.

And so he had retired years before. But it was a chance to go and work with him. And I ended up doing a PhD on the stability and collapse conditions for arches, and bolts, and buttresses-- so basically stone construction like in Gothic cathedrals. And again well, that could never possibly lead to a job. But it didn't matter. I was just fascinated by it. It combined what I wanted. It was mechanics and structures. It required some travel. I loved to travel. And it was intimately linked to history. And I'd always been fascinated by history and archaeology.

So to my great surprise, he had never had a PhD student in the field. He'd been working in it. He'd been pioneering the field for 40 years. But he felt like it was something to do in retirement, that it was not something you would corrupt young people with. Because it wouldn't lead to any worthwhile employment, you know. It wasn't the cutting edge of the field. Well it turns out, it is an exciting area of research. How do you assess existing buildings? How do you prove that they're safe if they have large cracks in them, if they're in an earthquake zone? So to my great surprise I found wonderful, wonderful technical problems that were unsolved. So I picked up problems that had been-- little theoretical problems-- that had been dropped in the 1820s by French engineers. In part because we stopped building in stone and in traditional masonry.

So to be in Cambridge, an 800- year- old university, studying with a master of engineering of traditional masonry structures, was a dream, an absolute dream. I mean I was three years in Cambridge. And then I got a Fulbright to spend one year in Spain. But I loved being outside. I loved climbing around on vaults. So I would climb up on the vaults of these cathedrals and study the cracks, and try to make sense of them. I'd give tours of these buildings. So it was like I'd found my calling as an engineer to really apply engineering understanding. And to my horror, what I discovered was that we, as structural engineers applying our tools, weren't able to answer fundamental questions about existing structures. And that is because our tools were developed for steel and concrete structures-- modern structures. And so to my horror, I realized, I came face to face with the idea that six years of excellent training as a structural engineer, if I was asked to assess a historic stone arch bridge or an old Gothic vault, I basically wouldn't know where to begin. And so that was very humbling and also very exciting, right? Because I found good problems to work on. So my PhD was just a joy. And Cambridge has a philosophy of throwing you into the deep end. That is, you're expected to go and do your work on your own, and come back every few months and talk to your advisors. So I brought some of that philosophy to my advising-- my graduate advising-- here at MIT. You know, a research student should flounder a little bit. And it should be their project. I'm not happy with situations where it's the advisor's project and you're telling the student what to do. I like to throw my students in off the deep end and say, go learn something and come back and teach it to me, you know. So I think that philosophy, I very much got from Cambridge.

INTERVIEWER: Your advisor at Cambridge must have been so thrilled when you walked in the door.

OCHSENDORF: Ha! Well that's funny. I wrote him a letter and I said meet with me. Any he met with me. And to use an MIT metaphor, I was drinking from a fire hose. I mean it was just a fountain of knowledge. And I realized that there were whole areas of my field that I knew nothing about. And here was a master. So I started meeting with him every week. And we would meet for a cup of tea at 10:30 every, say Thursday morning. And after three months of this I said, will you advise my PhD? He said John, my dear boy. He said, I retired for a reason. He said the short answer is no. He said, but I'm happy to meet every week. Well most advisors aren't able to keep up with weekly meetings. So I took it and ended up having another. The head of the department ended up also co-advising me and signing off on my PhD So he didn't formally accept responsibility for me. But he's still mentoring me today. And he's in his mid- 80s. So anyway, he wasn't exactly thrilled at the time because he'd retired. But I would say that we learned a lot from each other, and it's been a really enjoyable experience working with him.

INTERVIEWER: So you studied in Spain and you studied in Italy. And you wound up doing some work for Guy Nordenson and Associates. What were you doing there?

OCHSENDORF: So he's a structural engineer. He's on the faculty at Princeton in architecture. And he's a very creative guy. He was an MIT undergraduate. And I think he double majored in engineering and philosophy at MIT. So he's a very pensive engineer. And his firm did the basic structural engineering for Simmons Hall, a quite exciting new building on our campus, built in the late 90s. So he was just starting out as a practice. Now his practice is quite big and thriving. At the time it was me and one other person just doing some basic analysis. But it was working on projects as a structural engineer. So for example, designing a glass staircase where the entire structure was glass. So it was supported by a glass wall. So it was a taste of practice. You know, I was trying to make up my mind would I want to work in practice and that creative side, of engineering? Or would I like to do a PhD and become a professor.

And I you know, I tell my students that we should all maybe have five or six different opportunities, or possibilities, or applications, or paths. And then you choose the one that's most exciting. So it was a path that was open. I could've continued as a design engineer. It could've been quite exciting. And I'm still in close contact with him and his firm. And we collaborate on things. But ultimately I decided I was really interested in pursuing knowledge, and getting a PhD, and becoming a faculty member. But I do think it's good for faculty members to have a foot on the ground in the real world and occasionally consult on real projects just to know the state of affairs. Because otherwise we're really living in the clouds with our journal papers and our computer simulations. And so it's good to come back down to the ground sometimes.

INTERVIEWER: I totally agree with you. What's the story of how you got to MIT?

OCHSENDORF: In my second year of my PhD at Cambridge, I'd given a few seminars. And I guess things were going pretty well. And one of the faculty members invited me to apply for a faculty position in Cambridge in engineering. And he called me into his office and he said, there's an opening. You should apply. And I said oh no, you know, I'm just getting started on my PhD I couldn't possibly apply. And I walked out of his office. Well I got to the end of the hall and I said, well if he thinks I'm competitive for a faculty position, I must be. So I turned around. I went back in his office and I said forget what I just said. I'd be delighted to apply. Of course I'd like to apply. So that got me started about applying to academic positions maybe far earlier than the typical PhD student.

And so then I looked around on the web and I found the opening at MIT. It was in a building technology program. Which was pretty much an interdisciplinary research group based in architecture-- between architecture, civil engineering, and mechanical engineering. And there was a position open for a structures faculty member. And it looked good. And so I had just done the Cambridge application for faculty positions. So I reworked it a little bit and applied to MIT. And I was just about to leave to Spain. And I remember my first week in Spain I got a note from MIT saying, we like your application. Could you come and give a seminar? So that meant I was on the short list.

Well I didn't bring interview clothes I didn't have my slides. I was using trays of slides at that point. This was 2000. So I had to go back to Cambridge to get those things. I flew to MIT for a weekend and gave a talk in November of 2000. It went well and I was offered the job. And you know, I'd never gone to MIT. I'd never applied to MIT. I had this idea that MIT was a fairly narrow technical place. And I thought I'd have a chance of staying at Cambridge. So even when I was offered the job you know, I looked at it critically. And ultimately I decided it'd be a great place to develop for an academic starting out. There were a lot of resources. There were exciting people. And so I accepted the position I think, in my third year of my PhD and they waited for me a year and a half. Which I'm very grateful for. But again, as a result of that experience, I encourage my graduate students to apply for jobs starting early. So that hopefully they can have jobs waiting for them when they finish their PhDs but there was a lot of luck involved. But it worked out well. But if that professor hadn't invited me to apply to that Cambridge job, I might have missed the boat and never gotten the position at MIT. So I feel pretty fortunate. So I moved from Cambridge to Cambridge in 2002.

INTERVIEWER: Can you talk a little bit more about what the appeal of MIT was-- what it was you saw when you came here?

OCHSENDORF: Yes. I have to be careful here. But one of the things is that in my field of structural design and structural engineering, there were tremendous opportunities. That is, there were a few faculty members, but there wasn't a whole lot going on in relation to architecture, and design, and certainly history. So I saw it, in a sense, as a blank slate. And that's a good thing for a young faculty member, because you want to build up a group. You want to build up a lab and a field. And so that was ideal. The resources were fantastic. I mean for me almost immediately as a faculty member, I was advising graduate students from three different departments. That is very unusual. You know, I went to five universities in four different countries. I studied in Australia, in Spain, in England, and the states. And I always wanted a university where there were no barriers between departments. You could find a cool problem-- whether it was Inca suspension bridges or little carbon buildings or whatever the problem was-- and you could pursue that problem regardless of the confines of a discipline, or silos as you put it. And almost immediately I found that at MIT because I was advising graduate students from the technology and public policy program who were interested in policy issues. I was advising students from civil engineering, my own background, and from architecture who were more design-oriented. And that was absolutely thrilling almost from the beginning.

But it was tough. My first semester I remember I was teaching. I was lecturing four mornings a week. And I've since combined those courses to reduce the amount of lecturing. I was teaching way too much. And I'll never forget my very first lecture at MIT. It was a 90- minute lecture. And I looked up at the clock and I had only five minutes to go. And I still had, I don't know, 30 or 40 slides and a lot of ideas to get through. So I raced through the last five minutes. And finished, you know, and said, okay see you next time. And I released the class. And then, taking a closer look at my watch, I realized I'd let the class out 30 minutes early. So I since decided that the key to getting high student evaluations is to occasionally let them out early. But it was an accident. That was my very first class here.

But almost from the beginning, I found good students. And that is again, a comparison to other universities. When you're here, year after year and I'm about to do it next week, the applications role in. And they're fascinating, talented people who you want to work with. And that is a luxury that we have here. That we just get tremendous talent applying from all over the world. And then we get to take the best of the crop to choose from. And so I think I could only appreciate that if I were at another university. But here year after year, I've had amazing students who just come out of the woodwork and apply. And what you realize is-- and this is again part of the great joy-- as I have an idea or I may have a problem I want to work on, if I worked on it on my own, if I sat in the field and I worked on this problem out by myself isolated, you know I could only get so far. But what happens here is I mention a problem or a couple of ideas to a student and they take it and they run with it to places that I could never go myself. And then they come back and we talk about it. And then they go a bit further and again they take it places I could never go. So this is the ideal situation right? When a research student is leading you. They're running and you're kind of struggling to keep up.

But by the time at the end of their PhD they should absolutely be the expert in the world. Even at the undergraduate level because of my experience at Cornell, I readily believe that if you find the right topic and if you really are self-motivated and directed you can make original contributions. Our undergraduates do it all the time, and become an expert on something by the time you graduate as an undergraduate. So that has been absolutely thrilling. To see how students take my ideas and go places that I couldn't go myself. And so what happens is that, by virtue being at MIT-- having students like this, having the resources-- any affect that you could have as a lone researcher are basically multiplied many times over. So that's just been an absolute thrill. I've been on the faculty now for, this is my eighth year. And it seems like every year it gets better.

INTERVIEWER: And these same students I would imagine, contribute to your research as well.

OCHSENDORF: Oh there's no doubt. The students are, it's their project. They're the first author on our papers. But we're a team and there are problems that I pose to them. So absolutely they contribute. But you know most of all, I'm here because I want to learn. And so every semester students are teaching me things. And they are contributing to my research. And now some of them are going off and becoming professors too. One of my students is now a professor at Cambridge in my old department where I did my PhD, which is exciting. And now they actually have two students on the faculty at Cambridge. Another student, one in architecture, one in civil engineering. Another student is now a professor at the ETH in Zurich. Which is another place I considered for my PhD, but I was scared of the German. So anyway that's, you know again, the multiplying impact that your students can have as they go out in the world. It is very exciting.

INTERVIEWER: So one of the things that you're interested in is sort of the structural safety of historical construction. Can you talk a little bit about what it is that interests you about that?

OCHSENDORF: Sure. Probably the greatest building of all time is the Pantheon in Rome. I don't know if you've ever been there-- magnificent dome in the middle of Rome, which is about 2,000 years old. It's made of concrete. It's a marvelous, marvelous work of technology. What most people don't realize is that the dome, within the dome radially, going up towards the crown there's an oculus at the middle. But in the sides of the concrete dome, there are cracks. And the cracks are about this wide. Now they're not exposed to the public. There's some cosmetic kind of, lath and plaster that covers them up on an interior finish so you don't see them. But if you could let's say, strip off that outer plaster layer, you would see the basic structure of the Pantheon as a mass concrete dome, some brick and stone lower. But then a poured concrete dome with significant radial cracks and a big opening in the middle in a seismic zone. And it's been standing for 2,000 years. I believe it can stand for 2,000 more years.

Proving that that dome is safe is not easy. And for we, as engineers, the way we would approach an old structure with a crack in it, you might imagine that the first thing you would do-- let's say you stripped off the plaster. You were an engineer inspecting the Pantheon and you would say, have you seen the size of those cracks? Close the building. Nobody else is allowed inside. But then cooler heads would prevail and say wait a minute, it's been here a long time. But you could imagine that our first response might be, we've got to repair these cracks. So let's drill into the dome and let's fill it with steel. And if we did that, we would be taking a fairly short view of things. And the steel that we put in would corrode within 50 or 100 years and would cause greater damage. So, one of the things that appeals to me about trying to assess the old building-- so the difficult thing is to prove that it's safe in its existing condition. The easy thing to do is to come in and strengthen it using modern technology. But the really tough thing is to say, I've seen your building. It's in great condition. You don't have to touch it. Even if it has a cracks in it, that is, it's perfectly safe. And that's honestly a really challenging engineering problem. Particularly in seismic areas. So that's one of the things that gets me out of bed in the morning. And those are the kinds of problems that we're working on.

But there's another aspect to it. And that is that when you approach a building that's been around for awhile-- whether it's 50 years or 2,000 years-- you have to bring a certain amount of humility to the buildings. You have to say, you know the people who built this knew something. And I think that's where my background as an archaeologist, or interest in history, helps inform my engineering. Because you realize that we are not at a point in history where we are absolutely at the pinnacle of all time. And everyone who came before us knew less than we did. So the builders of the Pantheon didn't know anything about nonlinear dynamics, or soil liquefaction, or all the things that we know about now. But they built a building this has stood for 2,000 years, which is very impressive. And yet the science of understanding why this stood and what it would take to bring it down still isn't complete. So those are the kinds of live research questions that mean we get to go out in the field. We look at buildings. We take laser scans of buildings to find their exact geometry. And we're creating tools to try to be able to prove the building is safe. Someday in my life, I believe an engineer will claim that the Pantheon is unsafe. And they will say it needs to be wrapped in carbon fiber or some other modern material. and so we're kind of sharpening our tools to be able to say, well it stood for 2,000 years and here we can actually prove that it's safe with the simulation. So those are the kinds of problems we're working on.

INTERVIEWER: Will you be the one that figures out how the pyramids were built?

OCHSENDORF: Not necessarily. Some people at MIT have studied the problem a little bit. I really haven't. I think the pyramids, almost more than any other project, boggle the mind in terms of what people were capable of, historically, with fairly limited means. But I like to point out that the people who build the pyramids and the Pantheon in Rome are biologically identical to us. They have the same brain that you and I have. So I try to impress upon my students that when you study something like the pyramids or Inca suspension bridges, you're not talking about a primitive human who was, you know, far less intelligent than you were. So picture yourself, you and I physically there, trying to figure out how to build something.

So there is a field that I'm contributing to which is the history of construction. Which is a new field that basically looks at the technology of how things were built in the past. And this is a discipline between engineering, architecture, history of technology, and basically focuses on questions like how were the pyramids built? How did the Romans do foundation? So it's between many different disciplines but they're questions that we're fascinated by. So we've been organizing international congresses for the last seven years on this topic, the history of construction, so how things were built. And this is where an engineer who can do some calculations and can help figure out different methodology can make real contribution. So I'd like to see in basic engineering education, a strong historical component where we learn more about the history of engineering. Because I think we'll make better engineers as a result. Because when you study history you learn some of the methods. But you also scratch your head and say yeah, how where the pyramids built?

INTERVIEWER: Have you been there yet?

OCHSENDORF: I have not. And I'm dying to go to Egypt. My dream-- it's an interesting example because my dream when I was an undergraduate and was creating this major of archaeology and engineering-- my dream was to be the guy who would get the call one day when someone said, you know, we have a cracked lentil or a cracked stone beam in this tomb. And we're not sure how it happened or if it's safe. Could you come? And so I wanted to be the guy who got that call. I haven't gotten a call yet from Eygpt, but I hope one day I will.

INTERVIEWER: Okay well here's my offer right here on the spot. After a lifetime of wanting to go there, I did go, in December. I think you would be fascinated there.

OCHSENDORF: I have to go. There's no doubt.

INTERVIEWER: So when you're ready to make your trip, I can hook you up with a fabulous guy.

OCHSENDORF: Yeah that would be great. Yeah I mean, it would just be great. And I'm sure you've experienced what I was saying about just the achievements, and scale of it is just unbelievable.

INTERVIEWER: When you're inside, you really understand how did they do this as you look around. Because you just can't imagine how it was done. You might be able to imagine. I was not able to imagine.

OCHSENDORF: One day, one day I hope to get there. I'm sure I will.

INTERVIEWER: So one of the things that you're looking in is the study of sort of ancient construction for lessons that can be used in sustainable building. Can you talk about it and make that more concrete? Give us some examples of the kinds of things that you're looking at from history and learning?

OCHSENDORF: Sure. After I studied the Inca bridges, the one bridge that's left in Peru is a bridge that's made entirely out of grass. So it's the grass that grows on the hillsides. It's woven into cables to construct a bridge across the canyon. And this has been constantly repaired and rebuilt for over 600 years. Engineers at the time, some of my colleagues, wondered why I was studying these primitive grass bridges. And for me it's turned out that perhaps the most valuable lesson from that bridge for engineers today, is thinking about the life cycle of our designs-- the whole life cycle. Where do materials come from? How are they assembled? How are they maintained? How are works of technology part of the community valued by the community?

You know, we have a terrible problem in this country that infrastructure renewal is constantly underfunded and underappreciated. And yet, one of the things that made the United States such a tremendous place to live and work in the late 20th century was the infrastructure that people invested in. So it's an imperative that we keep that up. But specifically in terms of a sustainable technology, if we look at the model-- if we look at let's say a traditional, industrial model of how we create engineered products-- it's this. We go to natural resources. We mine them. So we dig up mountains. We find natural resources. We pour a lot of energy into them. We process these materials. We ship them all over the planet. And then we assemble them in place. And they might be in place for a few minutes, a few years if it's a laptop, or a few decades if it's a building. And then they basically go to the landfill.

So that is the industrial model of engineering design that we've inherited. And what I've found by studying historical constructions is that, particularly, let's just take the example of buildings. Buildings traditionally in many parts of the world were built out of local materials, materials that were locally available, that weren't necessarily highly processed, highly energy intensive. And buildings were made in such a way that they responded to their local climate. So all over the world you find vernacular architecture engineering designs basically fine-tuned over millennia for that specific climate: orientation of buildings, passive cooling mechanisms, passive lighting mechanisms. And I think in the 20th century we got a bit lazy. Because you could burn a pound of coal, you could turn on an air conditioner. And so we started building air-conditioned glass boxes all over the world basically, from Houston to Boston to Abu Dhabi. And I think our studies of history and historical construction methods say, wait a minute. There are other ways to build. And we can take cues from local construction methods. But also, we can take inspiration from traditional methods.

Just one example of that is in many parts of the world you find quite beautiful and durable wall construction made out of earth, made out of soil. It's either rammed into the wall or built into blocks like adobe, and then constructed. So you find earthen walls excellent for some climatic regions. You find farm houses in France that are 700 years old made of these earthen walls. And yet if you wanted to build an earthen wall in let's say Boston today, the building code wouldn't allow it. It might have a very low environmental impact. It might be an excellent environmental technology with low carbon emissions, low processing. It might create local jobs by employing people. And yet the building code wouldn't allow you to do it. So that's one example where five years ago an MIT student got interested in this. And we ended up building a test wall at MIT, a rammed earth wall with no concrete, much lower carbon emissions, behind the MIT Museum on Mass. Ave. It looks like a concrete wall if you walk by. But it's actually a long-term experiment in low carbon construction made out of soil.

So we're taking an inspiration from historical methods and we're saying that-- you know I'm not trying to take us back to the Stone Age. I don't want us to live in caves. But simply saying that we, as technologists, have this idea that maybe buildings of the future are Space Age, and are made of platinum, and are very you know titanium, very energy intensive materials. Maybe they're made of soil in some cases. Maybe they have radically lower carbon emissions. And how can you make beautiful buildings out of simple materials that are appropriate to that local condition? So it may not be the right material everywhere. So that's our hope.

Already we built buildings that have, for example, 90 percent reductions in carbon emissions over conventional construction just by starting from a different place. Rather than saying okay, we've got steel and we've got concrete. What should we build? We start from what is available. And how can we make the right building for this place, and radically save on environmental impact? And I think that's one of the great challenges in the 21st century is how do we, as engineers, bring carbon calculations into our designs? And how do we begin to think about the whole life cycle of our products? Whether it's a cellphone, or a laptop computer, or whether it's a building. And it turns out that because of my interest in historical buildings and thinking in long-term, it kind of has come naturally to ask ourselves what are the life cycles of buildings and their products? And how are ways that we can reduce the impact?

INTERVIEWER: I bet there's a lot of resistance to that approach.

OCHSENDORF: I don't know if I've met resistance as much as I mean, there are certainly barriers. There are barriers, cultural barriers, there are barriers and technical codes, all the things I was just mentioning. But at the same time we built a few buildings. And those buildings have won awards. And so, you know, we're able to say we're developing some technologies and some ideas. And you know, it isn't just ivory tower, let me publish an academic paper. But we actually built something, and by the way it won an award. So I think our buildings and our ideas are beginning to have an impact. And people are taking notice of them. But we face grave, grave challenges in the next few decades in terms of completely rethinking and redesigning the way our cities in our lives work, to make them much less carbon intensive. And so we need answers. And we're beginning to develop one set of answers. I'm not proposing you will be working in a rammed-earth skyscraper in Manhattan anytime soon, but simply that we can rethink how we design buildings.

INTERVIEWER: Your concept of green cities involves a lot of really fundamental changes in the way things are done. And yet you're pretty optimistic that it can happen?

OCHSENDORF: I am. If you look at the carbon intensity of the average European, for example, it's almost half of what the average American is. And that comes through better designs in our cities, if we prioritize pedestrians and cyclists. And I would say that, for me as a civil engineer, you know we have great potential as civil engineers to influence the future of cities, and to prioritize public transportation over the private automobile for example.

They're all sorts of hidden costs in our designs that we, as engineers, should be aware of. For example, health epidemics in the United States resulting from obesity. So if we design cities to be more walkable or more cycle-able, then you develop healthier populations as a result of that. And you know that gives benefits to society in terms of lower healthcare costs, higher productivity, less worker absenteeism. If you don't have you know 250,000 gallons of gas being burned an hour in the heart of your cities, you know giving off fumes in the middle of your cities, you have less absenteeism due to asthma and other breathing respiratory issues. And so I do think the concept of healthy cities can be achieved through better design, and that engineers have a leading role to play in that.

And so I would say that, historically, we as engineers have been a big part of the problem in terms of creating environmental issues and creating cities to some extent, that are not very healthy. But we can be a big part of the solution. But I will say that our cities right now have fairly low carbon intensity, compared to urban areas. So for example, New York is about a third of the national average. And that is because of well, living spaces are quite small, common walls for shared heating and cooling costs, and high- density residences with a lot of public transportation. So you end up-- you know by there it's virtue of maybe economic constraints that create that condition, or geographical constraints. But you know we, as engineers, can help to create cities that are healthy, beautiful, fun places to live and work and play. And do that while cutting carbon emissions radically. So that's a great challenge, but it's exciting.

INTERVIEWER: New York certainly does a better job than Boston does.

OCHSENDORF: I think so, you know. The first seven years I lived here in Cambridge, I didn't have a car. I rode my bicycle everywhere. And there aren't a lot of bike lanes in Cambridge now. And I had people, you know, pull over next to me and roll down the window and tell me to get a job. You know because I was clearly riding a bike, I must be unemployed. Whereas, you know, I've done a bicycle tour around Holland where the bicycle is king. And the whole city is designed around the bicycle and other public transportation modes. And we're getting there slowly in Boston and Cambridge. I would like to see a lot more. You know, it's occasionally dangerous cycling in Boston and Cambridge. It shouldn't be.

INTERVIEWER: The issue I think, in this country, to making the change is that people have to give up stuff to do that. They're accustomed to being able to take their cars wherever they want. And they would have to consider public transportation instead of cars. And in Europe with the longer history, they haven't needed, or expected, or wanted the same sorts of things that we've come to. .

OCHSENDORF: But it is also about priorities. And just as an example, we historically have enjoyed very, very cheap gasoline in the United States. Now we're getting into political issues, but in order to tax gasoline it's basically seen as you have a political death wish if you try to put a tax on gasoline. Whereas it's absolutely standard throughout Europe to have a pretty heavy tax on gasoline. Because they recognize for the issues of clean air, for public health, that they're hidden costs surrounding cheap gasoline and now global warming. And so obviously these are great challenges for society. But a certain tax on nonrenewable fossil fuels that negatively impact public health should be a no-brainer. And if you can begin to pay for improved public transportation as a result of the tax on gasoline, well that's a great thing. But look I'm not running for public office so I can freely say that.

INTERVIEWER: Yeah there's not a lot of efficiency right now going on in Washington.

OCHSENDORF: Oh no, no.

INTERVIEWER: Let me ask, do you have any comment or do you want to say anything about you MacArthur Grant?

OCHSENDORF: Well, I mean it was just one of the most tremendous surprises that could ever happen to anyone. This grant is something that occurs in secret. There's a nomination process. A lot of people write letters for you. And it goes on without your knowing. Until the telephone rings one day and you get this person at the other end of the line that says, are you alone? Are you sitting down? And you think, this is pretty creepy. And then in my case he said, I'm the president of the MacArthur Foundation. I'm calling to tell you you've been awarded the MacArthur Grant. It just didn't seem possible. And now, of course, I've since learned that many close colleagues not only nominated me, wrote letters.

But you just feel, more than anything, surprised. But also, why me? You know there's so many talented people in the world. And so in a sense, it's raised the stakes for me to try to have a greater impact with my work, to try to continue to leverage the resources that I have at MIT, and now the honor and award from the MacArthur Foundation, to try to make our work have a bigger impact. So it's absolutely life changing, but also certainly for me, a huge surprise and just a real challenge to try to live up to it. Because it's yeah, a big surprise.

INTERVIEWER: It keeps raising expectations.

OCHSENDORF: Yeah.

INTERVIEWER: In terms of the MIT environment, how do you see the School of Architecture and Planning sort of fitting into the puzzle, its role at the university?

OCHSENDORF: I should say that I'm associate professor of architecture. But I also have a joint appointment in civil engineering. So I'm associate professor of civil and environmental engineering as well. Most of my work and my appointment is in architecture. Maybe first I could characterize architectural education and engineering education. Engineering education, as I said earlier, is often highly constrained, highly over-constrained. So you have a few variables and you have a specific question-- what is the deflection of a certain beam under certain load, or what is the energy required to do this-- which allows you to manipulate the numbers, plug into equations, and come up with the one answer. So it's very over-constrained in a way that engineering design isn't really. And some aspects of our engineering education are making it a little more open-ended. But in any case, here's a historical model of engineering education. Find the answer, put a box around it.

The historical model of architectural engineering, architectural education, is way under-constrained. That is, there are a lot of variables. We can't really quantify them. We don't have any clear equations. It's up to you to find what should the building look like. What should the city look like? And the real world, of course, is exactly in between these two. And that is fascinating and challenging. Because for me as an engineer, there are times when I'm in the School of Architecture where there's tremendous creativity. And architecture students come up with solutions that I personally could never come up with. Because they are so creative. And in the sense, I'm constrained by my knowledge of technology or my knowledge of efficiency and materials, that basically keeps me in a certain box. Well the architecture students are able to think outside of the box, and dream, and go places. And for me what's exciting as an engineer, is how do you then interact with that and say, well that's a marvelous or that's an amazing idea. But what if we did this? So you can take inspiration but then you can ground it in ways that creates uplifting, beautiful objects that are functional and efficient. And that for me is exciting.

So the role of architecture at MIT-- first I should say that we have the oldest school of architecture in the United States-- when MIT was founded from it's beginning, it had an architecture school which is the oldest formal architectural program. There are a lot of things we're tremendously proud of. Our valedictorian in the 1860s was a man named Robert R. Taylor who's the first African American architect in the United States, who went on to design the campus of Tuskegee and other great works of architecture. So the school has a long, long history. But I would say many of the great problems facing society today are open to problem solving by architects whether it's healthy cities, whether it's greener buildings, whether it's a flow of resources, or incorporating more efficient energy devices into our every day design. So scientists are asking why. They're trying to understand the world. Engineers are saying why not. They're trying to figure out what is possible. And architects are trying to take works of technology and apply them in a way that is functional.

It's difficult for me not having trained as an architect. But I'll simply say that there have been a few times in my life when you go in a building or great square, and you feel what is architecture. What is a great space whether it's in terms of the proportions or the scale. After seven years on the faculty, I have tremendous, tremendous respect for my colleagues who are architects. And yet I would like to see architecture be a little more constrained in terms of the grave environmental challenges we face. And I would like to see engineering to be a little more creative. And therefore trying to bridge these two fields, one highly over-constrained one highly under-constrained, is exactly where I'd like to be.

And at MIT I will say that the architects have been contributing a lot in terms of design culture. So the model of education in architecture is a studio model of instruction whereby you're given a problem. So design a visitor's center along the Charles River for MIT. And it's very open-ended. What should it be? What could it be? How do you link it to the community? What are the materials? What does it convey? How does it work as a machine? How much energy does it use? And these very open-ended problems are solved in architecture by students drawing, sketching, brain-storming, putting their ideas up on a wall, presenting it, having people critique it, and then go back to redesign it. And that model of education in being used a bit more today in engineering. There's some very exciting classes in mechanical and in civil engineering that are using that kind of studio model, or review model, or kind of critique model, where students present their designs orally, graphically. And then people pick them apart. And it can be very humbling. Because you work hard on an idea and then there's a culture in architecture to not pull any punches. Basically to tell people what you really think and to rip apart the design. And that can be very difficult. But you have to learn to defend your ideas and understand why.

So the bottom line is that architecture, in it's creativity in it's trying to balance a lot of different variables, and trying to find which variables are most important, is a wonderful discipline and has a lot to teach engineering. But engineering also has a lot to teach architecture in terms of the rigor and the ability to quantify things. And particularly, I'll just give you one example. If you have a car, you know the mileage of your car. Every American can talk about gas mileage. We have public literacy about gas mileage. If we look at where fossil fuels go, if we look at where spending goes, and if we look at carbon emissions, buildings by far have more carbon emissions and use more fossil fuels than automobiles. In fact, more than transportation generally. And yet the public-- and even more astonishing-- professional engineers and architects, don't yet have a language for talking about the efficiency and energy mileage of our buildings. And as we move forward in the next few decades, it's very clear that heads of state and governments, are asking for carbon emissions and reductions in carbon emissions. And therefore we have to develop literacy in terms of mileage of buildings, energy performance, carbon emissions, to the same extent that the public does. And we have to bring greater methods of quantifying performance and more rigor into our buildings.

And so anyway, it's an exciting time to be working in the field because there's tremendous demand for greener buildings, for less environmental impact. And how do you do this in a way that comes at lower costs, that gives greater productivity, you know more beautiful places to work? We've probably all experienced the days when, on a beautiful spring or fall day in Cambridge when it's 68 degrees outside, you'd love to be able to open your window. And many buildings are sealed glass boxes with air conditioning that are burning coal from far away to run an air conditioner. And you know, the old campus at MIT is a great model in many ways. Because many of the windows are still operable. You can let in a breeze. You get a lot of daylight. Thermally they're not as efficient or as tight as we would like our modern buildings to be. But in any case, I think we are moving towards a public awareness about the benefits of green design and buildings. And I think MIT we are a leader in this area. And we're poised to do even more in the next few decades. Because it's simply one of the most pressing problems in terms of addressing our climate change and reduced environmental impact.

INTERVIEWER: What do you sort of see as the strengths of someone coming to MIT to study architecture, or structural engineering, environmental problems. What sets MIT's culture, in those areas, apart, or education?

OCHSENDORF: I would say we're really focused on problem solving. And we're focused on interdisciplinary problem solving. So for example, right now I'm directing a program sponsored by the cement and concrete industry to try to find ways to both quantify the environmental impact of cement and concrete in construction, look for areas where it really is one of the best environmental solutions, and look for areas where things can be improved. And if we look at that project, it's very interdisciplinary. We have people from a lot of different fields working on the problem. But we also are working closely with industry in terms of trying to solve the problems. And I would say that's why I'm at MIT. And that's why our students are really at the forefront of so many different problems that we're trying to solve. We aren't doing it necessarily in a vacuum. So in that case, we're working closely with industry. We're trying to imagine what our built environment should be like, what are building should be like in 50 years. How do we quantify over the full life cycle of the building?

And so that's a great advantage for students. That not only are you solving tough problems, you're doing it in a way that you're learning skills. You're working side by side with people who have other skills or complimentary skills. And you're working closely with industry, and with government in some cases, trying to figure out how to move us forward. And so for me, I think again that's very special. You see this at some universities. But almost more than any other place I've been, MIT really is oriented towards solving the problems. That's just a terribly exciting thing to be involved in.

INTERVIEWER: So let me ask about some of these groups that you're involved in: the Masonry Research Group.

OCHSENDORF: So when I arrived at MIT, I was coming with a background in the mechanics of masonry arches and vaults. And so you can imagine that many MIT students who are coming here for graduate school, for example, anticipate they're going to come to MIT and work on high tech things. And yet I've been very successful with attracting students and getting them excited about some of the historical problems, and the assessment of old buildings. And so this is my main research group where I have graduate students who are trying to understand how old buildings stand up and fall down. We do fairly sophisticated computer models. We also do fairly simple little block models where we make blocks and we stack them up and we study the stability of them. So you would think I was kind of playing with children's toys or children's blocks. So they're very simple models, and yet we can gain insight into the mechanics of the problems that we're studying.

And so that group is, I mean, this is really my research group with Master's students and PhD students. And we're looking at problems like earthquake assessment of old buildings. Were looking at creating tools, design tools for trying to design new buildings in masonry. And that may include blocks, building blocks that are made of very low carbon construction materials, or even carbon negatives. So building blocks that actually absorb more carbon then they give off in making them. So how can we begin to build buildings that are maybe even net carbon sinks? So what it takes to make the building, actually takes carbon out of the atmosphere rather than admitting it into the atmosphere. Our buildings in our cities are some of the largest emitters of greenhouse gas emissions. So how can we turn that on its head and move our buildings closer to carbon neutral or even carbon negative. So that group, it turns out again, although we're primarily interested in historic buildings, some of the lessons we're gaining from how traditional construction methods work, we are able to apply them to green buildings in the future. So that's the Masonry Research Group in a nutshell.

INTERVIEWER: You sort of mentioned the concrete sustainability hub.

OCHSENDORF: Yes. So that's one of these opportunities that comes to you when you're at MIT that you just can't say no to. And it's, you know, why I'm at MIT. Because I want to change the world. And I want to make the world better. And that's true of our students too. They come to MIT for those reasons. And so this was an example where the industry-- the cement and concrete industry-- came to MIT with a substantial research grant to try to help them figure out where their industry is green today, and where it could be greener in the future.

And so it's an interdisciplinary group with civil engineering, architecture, material science, and it has a policy component. So it's just the perfect kind of MIT problem because it's not confined to any one area. And you know, we're working on big issues like cradle to grave assessments of buildings. So from the extraction of raw materials, they're assembled into a building. The building operates for a certain number of decades. And then the building is taken down. How does the building perform? How does it compare to other building types? How could it be made better? And so that's really the work that we're doing at the concrete sustainability hub.

INTERVIEWER: So I'm sort of intrigued by the Center for Materials Research in Archaeology and Ethnography.

OCHSENDORF: Yeah. So I'm affiliated with this group. It's really run by professor Heather Lechtman and material science. And it's another indication of how special MIT is, that our material science department has full-fledged archaeologists on the faculty who are interested in the history of material culture. And they study things like metalworking in ancient cultures, and fiber processing in ancient cultures, and teach classes on them. And so that group is a group that spans across several Boston area universities directed by Professor Lechtman, that I'm affiliated with because of my interest in archaeology as an engineer.

And so again, it's very typical of our interdisciplinary approaches to problems that the material scientists at MIT isn't only interested in Space Age materials, but also is interested in how the cultures 1,000 years ago work with materials? What were the processes? I think it speaks very much to the mind in hand nature of MIT. The fact that we have a glass lab. We have an iron forge. Students work with materials. The glass lab is always oversubscribed. More students want to use it then have access to it. And again it's not enough for us just to study let's say, the phase changes of a material, but also to work it with out hands and really feel it and understand it. So that center is typical of that.

It was Professor Lechtman who proposed several years ago to build an Inca suspension bridge on the MIT campus. Which was very exciting. It was part of a class that she taught with colleagues in material science that I helped consult on. Which was like a dream come true to see MIT students making cables in the same way that the Peruvian communities make that bridge, and then actually building a bridge on our MIT campus. It was only supposed to be up for a short time. And people were so excited about it, it stayed up for longer. And you know we encountered things in building the bridge that helped us understand better the way it was done in Peru, and helped us understand the challenges.

In any case, it's a very special group which basically consists of archaeologists who are interested in how materials are processed, and how they're made. And in some cases trying to recreate that to understand it. But also do fairly sophisticated studies of metals in order to determine where the materials came from. And it's a good example of how archaeology is inherently interdisciplinary. So you know, carbon-14 dating comes from physicists. But that and other methods of dating have revolutionized archaeology. So some of that work is going on at MIT. So for me, it's been a nice bonus with my love of archaeology, to have those colleagues here.

INTERVIEWER: I'd like you talk a little bit, just briefly, about some of the projects that you've worked on: the soil cement vaults in South Africa.

OCHSENDORF: That was basically a project brought to us by an architect from South African named Peter Rich, an absolutely amazing designer. And it's for a World Heritage Site in a remote area of South Africa. And the South African government, to their credit through the South African National Parks said, we want this building to create jobs. We want it to use local materials. We want to have a low environmental impact. And perhaps the model of how a building like that would be built in rural Africa today, is to bring a boat from overseas with overseas workers and overseas materials. They come for three years, they assemble the building, and then they leave.

And Peter Rich, a South African, had a completely different idea. What can we use from the local materials? And how can we build the building out of that? So he-- probably five years ago now-- he came to Cambridge, maybe in 2005 or 2006. And he stayed at my house. We spent four or five days. We sketched ideas. We talked about the form of these vaults. And we ended up designing vaults-- that is structural ceiling for these buildings-- with no steel, made out of local soil with a small amount of cement as a binder. And I sent two MIT students to South Africa the help develop the technology for the bricks, and to help build some samples vaults, and train workers to build the vaults, and then build something like a dozen, fairly long-span arches, vaults, and domes for this World Heritage Museum out of very humble local materials. And that building started off as a side interest. But it's gathered steam. And most recently it was just named the 2009 World Building of the Year at the World Architecture Festival.

So Peter Rich's vision of an architecture made of local materials, built by local hands at lower competitive cost that is appropriate. And we were excited to play a role in it. So it's an example of what you might call high- tech, low- tech. Because we used fairly sophisticated software developed here at MIT to find the right shape of the vault and to figure out the basic design of the building. And yet the technology that we were using was 700-year-old vaulting system that came from the Mediterranean, combined with fairly humble earthen bricks, to make what we think are really beautiful spaces. So unfortunately I haven't been to South Africa yet. And I'm not able to go for the World Cup this summer which is an absolute travesty. But sometime I have to get to South Africa to see that building because several different students contributed to it and it was one of the most fulfilling projects that I was lucky enough to work on. But it's an example where architecture can be invented, and doesn't need to stamp out the same. You know, open up a drawer, pull out a design that's been done before, and say here build this. It costs x dollars per square foot. So we can restart from square one and think about what is appropriate for the site. And I mean frankly the fact that the project has won so many awards and garnered so much attention is beyond our wildest dreams of what impact a project like that could have. But it's leading to other projects in other parts of Africa, and around the world saying, can we rethink, use local labor, local materials, and make buildings that are competitive, low cost, and much lower environmental impact? So it's been exciting. And it's an example where we're doing research, we're writing papers, but then if we can find ways to apply them in the real world that can hopefully inspire others, then that's great. It's very fulfilling to see you develop research, you develop ideas, you develop tools, but then to see it put into practice is really exciting.

INTERVIEWER: And wouldn't it be interesting for the continent of Africa to lead the way?

OCHSENDORF: It would. At an MIT Energy Initiative meeting, a managing director of the World Bank who's Nigerian-- I presented that building as a low energy construction method. And she jumped up and she says, this is what we need! We need beautiful buildings made of mud! Because again, there are cultural ideas in developing countries. You know, they don't want to live in primitive buildings. They want to live in beautiful, modern, high- tech buildings. But at the same time I don't think they should follow in the same footsteps of North American architecture and construction. Each place should have its own appropriate design. So that's really what we're trying to help provide inspiration for. INTERVIEWER: Do you want to say anything about stone masonry vault prototype?

OCHSENDORF: Sure. That is a project where a group in Texas, who's been building absolutely beautiful stone houses, stone structures for a few generations, called Escobedo Construction, has the construction know-how, but not as much of the technological know-how. And so we're teaming up with them to try to re-imagine stone vaults in a contemporary design context. So how can we use local materials and no steel? Some of these vaults may have design lives of a lifetime of let's say 10,000 years. Whereas an average bridge in North America may have a design life of anywhere from 30 to 50 years because they corrode over time. So if you don't put steel in it, and you use fairly durable materials like stone, you could design something that could conceivably last for 10,000 years, and yet be beautiful, and functional, and cost competitive.

So that's an example. It's a spin-off from our research. And I should say that I have a small consulting company on the side that I started with two former graduate students of mine. And MIT makes it very easy to start companies. And even though I will say that in terms of from a business standpoint, we were fairly clueless. We were working on projects and not sending anybody an invoice for our work. But MIT has a venture mentoring service that helps students and faculty members who have an idea. Or want to found a company, or get technology out there. So they saved our lives. Because they really helped us get the venture off the ground.

INTERVIEWER: It reminded you send invoices.

OCHSENDORF: Reminded us, for example that, when we do work we should bill people for our work. Which you know, doesn't come naturally to an academic. Because we work on problems because they're exciting. But it is nice to be paid for your work. And MIT gives us some leeway to do a certain amount of consulting per year. So again, we're taking our research and putting it into practice. And working on some stone vaults and contemporary architecture is a way of doing that. And this May in a museum in New York, the Cooper Hewitt Design Museum, we have a vault that's opening which is made of 100 percent recycled content, bricks, including 30 percent raw sewage. So very, very basic waste materials that are processed to make a brick. And then we're building a vault out of it that will be up in New York in this museum for about nine months.

So it's a way of basically again, trying to fire the imagination of architects and engineers about materials, and structure, and form. And you can make a beautiful, sexy form that's made out of humble or low impact materials. So that's another example where our research into basic mechanics and development of software, can be put into practice and hopefully be picked up by a by designers. Yeah.

INTERVIEWER: Maybe you can figure out how to build bridges out of empty water bottles.

OCHSENDORF: Hey there's a thought. We certainly are producing a lot of water bottles. And so what do you do with them? But you know, I think it is true that that is a fundamental challenge. How do we take-- instead of mining virgin materials, virgin natural resources-- how do we take the waste stream of society, which is absolutely massive, these flows and flows of materials, and how do we make useful building products out of them and make buildings out of them? Those are great challenges that aren't easy. Because the building code doesn't really encourage experimentation in new materials. So if we're going to develop materials made out of waste products that can be used in construction, they have to go through a lot of testing. But we're trying to push on that front by using waste products in new construction.

INTERVIEWER: So we're close to the end of our time And before we run out of time completely, I'd like to know if there's anything that you would like to say about MIT, your department, your school, your work, your future aspirations? Like what have we not talked about that you think is important?

OCHSENDORF: I mean I would like to say that the great joy at MIT is working with the students. And that every year new people come and knock on my door with ideas and enthusiasm. It's a way of, come to MIT and live forever. Because there are always ideas, there's always new energy. And that's tremendously thrilling, on one hand. On the other hand, fundamentally, I like who the students are and where they come from. They often come from fairly humble backgrounds. Many of our students are first generation college kids. That's true from the very beginning. It's true today. And you know, it really is a meritocracy. And that's a phenomenally exciting endeavor to be part of.

Every year I take the seniors in a Spanish program house on campus out to dinner. And I ask them how they got to MIT. And in many cases their guidance counselor told them not to apply. They said you won't get in. But these kids didn't take no for an answer, or they knew a friend who came to MIT, and they believed in it as a place that would recognize merits and would give them a chance. And it happens year after year. So it's an absolute thrill working with the students.

And I do think the playful nature of MIT is important to me as well. So we take ourselves very seriously. We work on really hard, difficult problems. And we're trying to make the world better. And yet, you know, we also don't always take ourselves so seriously. You know I once had a student come into my office with a backpack and he said, I heard you know a lot about fibers and you know making short fibers carry loads by braiding them together. Well that was the Inca bridge issue of grass fibers. And I thought okay, yeah sure. I know a little bit about weaving fibers to carry loads. And so he opened up his backpack and he started pulling out wads of one dollar bills in attempts of braiding together one dollar bills to make ropes. And I thought, what is this guy doing? He said, you know I'm an artist and I'm trying to-- he was a graduate student-- he said I'm trying to hang the heaviest object that I own from the ceiling using only one dollar bills. And I said, what's the heaviest object you own? He said, oh it's a 700 pound steel safe. And so I started working with him. And we learned to braid together these dollar bills. We found a design that was quite strong, that could support a lot out of woven dollar bills. And these ropes made of braided dollar bills were absolutely beautiful. They were just these stunning ropes. And he successfully hung a 700 pound safe using only one dollar bills with no glue or anything.

And again, we took lessons from the Inca bridges. On one hand you could say a completely frivolous project-- it was an art project. It was an installation that opened people's eyes. But it was also an example of when you're at MIT, you never know who's going to walk through the door and ask you a question. And you also never know what your particular expertise could be applied to. And that's one of the really exciting things about being here, and why it's easy to get out of bed in the morning and come to work.

INTERVIEWER: I do get that feeling that you genuinely love teaching.

OCHSENDORF: I do. I do. I love being in the classroom. It's not easy when your students are all smarter than you are. We only stay ahead because we've taught it so many times before. But I do love teaching. And at the same time you know, I'm deeply dissatisfied with my teaching. I'm deeply dissatisfied with my writing. It can always be improved. And one of the things that I hope to do now that I've just recently received tenure at MIT, is to spend more time revamping my teaching, and put more effort into it, and develop some new classes. Because it is one of the most rewarding things that we do, is interact. I teach both undergraduate and graduate students. And I get a thrill every time I stand in front of a class. So I hope I can convey that.

INTERVIEWER: Anything else?

OCHSENDORF: You know, you put me on the spot with what else I wanted to say about MIT. I just feel like there must be one or two things that, I don't know. I've probably talked about MIT enough. But yeah, I guess it's okay.

INTERVIEWER: Are there any other ways in which you feel MIT has helped your work, or helps your work in an ongoing way. You've talked about the resources. You've talked about the students. You've mentioned colleagues, the collaboration.

OCHSENDORF: I mean, I think it's terribly important that our colleagues-- you know I've emphasized the students are source of inspiration-- but our colleagues are as well. And you know, one thing I miss from Cambridge was that twice a day we would take tea or coffee breaks. And all of the faculty and all the students, at 10:30 and at 3:30, would all go to a common room and have tea. And that meant that you talked about problems together. And we do it at MIT, but we need to do it more. And you know, when you talk to colleagues in different fields, you learn that you can help each other think about problems in new ways. And working together with colleagues is another of the most rewarding aspects, because you're constantly learning from really, really smart people who know about things that you know absolutely nothing about.

But I do think there is a danger at MIT that we are so in love with our own work and what we're doing. And we're all so busy that we sometimes don't take the time to allow room for socializing with colleagues, or the chance to learn more from each other. So I think it is a challenge for MIT in the next century, how do we maintain a balance of you know personal life and professional life? And how do we also encourage more, let's say playful or social interactions among our faculty? And some of it does go on. And you know, there are informal faculty dinners and things like that. But it is something that we could encourage more. So it would be nice if we had let's say, I don't know, free beer every Friday at 5 o'clock, and got people to go have a pint of beer and talk to each other. Because that doesn't happen as much as it should. Yeah so that's ending on a slightly negative note. But hey, free beer.