

**INTERVIEWER:** Ed Roberts is the David Sarnoff Professor of Management Technology, professor of technological innovation, entrepreneurship, and strategic management at the MIT Sloan School of Management. He's the author of *Entrepreneurs in High Technology: Lessons from MIT and Beyond*, a foundational study of high technology entrepreneurship. Professor Roberts was a founding member of the MIT System Dynamics Group. He is founder and chair of the MIT Entrepreneurship Center and was a founder, and for over 30 years chaired, MIT Sloan's Management of Technological Innovation and Entrepreneurship Group.

Most recently, he co-created and directs the MIT Sloan Entrepreneurship and Innovation MBA track. Professor Roberts is internationally known for his research, teaching, and active involvement in many aspects of technology management, including technology strategy, corporate venturing, product innovation management, and technology-based entrepreneurship. He has also been actively involved as a co-founder, board member, and angel investor in numerous high-tech startups.

Professor Roberts has authored over 160 articles and 11 books. He is also the author of an influential study, "Entrepreneurial Impact: The Role of MIT," exploring and quantifying the impact that MIT entrepreneurship has had on the US economy. And it's worth mentioning that Professor Roberts holds four degrees from MIT. Thanks very much for coming in today.

**ROBERTS:** Thank you. I'm delighted to be here. I should be tired from listening to the introduction, but I'm motivated instead.

**INTERVIEWER:** Sorry it's so long. It could have been longer. So let's just start at the beginning. Tell me a little bit about where you were born and where you grew up.

**ROBERTS:** I was born in Chelsea across the Mystic River Bridge. I grew up there, went to school there through grade school, high school. In high school, I was in the tech course, which today, I'm quite sure, Chelsea doesn't have. But in those days, the tech course was focused on getting high school kids into MIT.

And in my senior year at Chelsea High, three of us applied to MIT. Two of us got accepted and went to MIT. The third one, unfortunately, didn't get accepted to MIT and had to go to Harvard. So I grew up there.

My father was a one-man oil company. He delivered home heating oil to residences and small businesses. And consequently, working with my father from when I was a little kid, I learned a lot about business, but really at a sort of one-man business operation point of view. But I had rudiments of accounting, and competition, and pricing, and everything else that a kid would learn from his father, helping out on a truck and delivering oil to various customers.

**INTERVIEWER:** So what were you interested in as a kid? Was it technology, engineering, you mentioned business, or was it a combination of both?

**ROBERTS:** I'm not sure what I was interested in when I was really young. I know that when I was in the sixth grade, we had one of these little essays on, what do you want to do when you grow up? And I know, because I had saved the essay for a long time, I wrote that in the sixth grade I wanted to go to MIT, and I wanted to be a civil engineer. And I explicitly said I wanted to build big buildings and bridges and all these kinds of things, which I guess, to me as a kid, sounded like a very exciting thing.

I have no other track of what my thoughts were in that direction until my junior year in high school when I was getting around to thinking about applying to college. And by that time, I had shifted slightly. I still wanted to go to MIT, but I wanted to be an electrical engineer.

And in particular, the beginning stages of computers were starting to become obvious. And I said that I was interested in computers, whatever that meant, because I had no personal experience with anything that resembled a computer in any form. So that was, as best I can reconstruct, my dream.

The only other kind of touchpoint that I have that gives me a memory of my life relating to MIT was that my family were real great classical music buffs. And consequently, we used to go to the Esplanade concerts of the Boston Pops Orchestra during the summertime. And we did that on Saturday mornings, and we also did that in the evenings.

And I remember distinctly, and I wrote about it in the preface of my 1990 entrepreneurship book, that in the evening, looking across the Charles River from the Esplanade at Memorial Drive, you could see lights on two buildings. One building was the MIT Dome, which was lit at that point in time. And the second building was what is now One Memorial Drive. And it was Laboratory for Electronics.

And the roof of the building was a blazoned logo that had a flashing lightning rod going through the LFE aspects of Laboratory for Electronics. And I remember as a little kid seeing that at night and being intrigued by whatever this thing was that is now One Memorial Drive and the MIT Dome. I knew what the MIT Dome was, but I couldn't imagine what kind of linkage it was on Memorial Drive.

**INTERVIEWER:** So ultimately, you made it across the river. Your ambition in high school came true. You came to MIT as a freshman. Tell me a little bit about your first impressions of MIT, what it was like at that point as an undergrad.

**ROBERTS:** I came in, and I knew I wanted to be in electrical engineering from the start. I also knew that I wanted to be involved in student activities. I had been very active in high school. So in my freshman year, I got involved in the Debate Society. I debated for four years. I became head of the Debate Society at MIT. I learned a lot, I think, from that.

I really thought, initially, MIT would be an extraordinarily difficult place. And I was quite panicked about it. I don't know whether every freshman is panicked. I think it's not unreasonable. But I actually blitzed through my freshman year. I got four A's and one B in the first semester, which made me relaxed. And I got four A's and one B in the second semester.

So suddenly, I was now comfortable. And my comfort led me to be very expansive in the things I was willing to take on. And I started getting into not just the Debate Society. I began getting involved in fraternity and other things and the like. So as an undergraduate, I overloaded heavily in my classes. I took 14.01, which was the first course using Samuelson's textbook, as my humanities elective in first semester freshman year. I loved it. And I knew nothing about economics until then.

Second semester, because of the first semester, I took 14.02, which was the second half of the Samuelson textbook, *Principles of Economics*. I think the book was written a few years before. And beginning in my sophomore year, I started overloading in economics and in management, coming to what was not yet the Sloan School to begin learning more about management but staying with electrical engineering.

In my sophomore year, I got into Electrical Engineering Co-Op, which was a competitive admissions process. And I became a 6A General Electric Co-Op student, which after the fact, I really thought was a remarkable experience. I think that in the four semesters of Co-Op work at GE, that I learned an enormous amount. I learned much more there, I believe, than I did in the coursework that I was taking as an undergraduate.

But by the time I was finishing my graduate degree in electrical engineering, I also was just about done with what was required for a Master's degree in management as well. So I really had this double education during the first five years of my life at MIT and at the same time, very heavily engaged in activities. When I was a senior, I was both vice president of my fraternity, and I was chairman of the MIT Activities Council.

So the Activities Council was the place where all the major activities at MIT were represented. And we did whatever were the policy and governance activities of that. And believe it or not, friends that I made in 1956 and '57 in Activities Council are people I still relate to today as leading MIT alumni and the like. So it's really been astonishing to me how from 1953 through to 2012, there's been so much people continuity in their ties to MIT.

**INTERVIEWER:** Sounded like a busy guy.

**ROBERTS:** I was a busy guy always. And I remember one of my professors was giving me the business about the fact that I was overloading so much, because I would typically be taking seven courses a semester. And he said that the fact that I was overloading was causing me to not concentrate enough on my electrical engineering subjects and that my grades were suffering. Well, they couldn't suffer that much, because I had to have at least a B average to get into graduate school on the 6A program. But yeah, they were suffering relative to what I perhaps could have done had I focused only on studying electrical engineering activities.

But I said to him then, as probably a 19-year-old kid, that I was conscious that I was making a choice and that my choice was to learn more about a wider variety of things, rather than to focus narrowly. And by that time, when I was a junior, I was pretty sure that what I wanted to do in life was to become an engineering manager, that I wanted to link together my Course 6 background with what I was studying-- and I didn't think I was going to get a degree in it-- but what I was studying in the Management School.

So to me, that was going to be my life. I was going to be an engineering manager, and that would be a really interesting thing to do. And I had that as my view, actually, until I entered my doctoral program in economics. I still thought, even upon entry into a PhD program, that that wasn't what I was going to do, that I was going to quit before I finished the PhD and leave MIT and go out into industry and become some kind of a manager. But I hadn't counted on the experiences that I had when I became a doctoral student.

But I'll tell you maybe one of the most interesting, certainly important in my life, things that happened when I was an undergraduate. I was taking some course in the Sloan School. I have no idea what it was. There was an instructor who was teaching us, and characteristically, in Course 15 in those days, a large fraction of the students were engineering students, not management students. So the instructor made some comment, and he said, you guys think you're so smart. We just had the inventor of the computer join our faculty in the Sloan School.

And I turned to the kid next to me, who was also an electrical engineer, poked him, and said, what in the world is John von Neumann doing coming to the Management School at MIT? Because when this instructor said "the inventor of the computer," my best guess was, well, that's John von Neumann at Princeton. So being not terribly bashful, I raised my hand, and I said, who is this person who's just come here? And he says, Jay Forrester.

And I smiled and poked my EE buddy, because we knew who Jay Forrester was. Jay Forrester had run the Whirlwind project at MIT. Jay Forrester was the inventor of the magnetic memory core. Jay Forrester was running Division 6 at Lincoln Laboratory, which was-- we knew that, because Forrester was a really famous, important MIT computer guy.

And I said, well, that's interesting. I wonder why in the world he wants to come to this place, a management school? Class finished. I had a break in my schedule. I went up to the fourth floor of the Sloan building to the dean's office and walked in and said, my name is Ed Roberts. I'm pretty sure I was a junior in electrical engineering. I understand that Jay Forrester has become a professor here. Could you tell me how I would find him?

And the person in the office said, sure, he's just four doors down the hall. And I said, okay, thank you very much. I walked down the hall. I walked into this office, JW Forrester on the door. There's a secretary there. I said is it possible that I could see Professor Forrester?

And she says, and who are you? I said, well, my name is Ed Roberts. I'm a junior at MIT. And what do you want to see him about? I said, I just would like to talk to him about what he's going to be doing here in the Management School at MIT. She says, well, let me see. She gets up, knocks on the door, opens up his office door, goes in, closes it behind.

She's in there for a couple of minutes. She comes out and says, Professor Forrester will see you. I said, oh, thank you. I walked in, Forrester is sitting behind this big desk and looks up at me. And he says, well, good morning. And I introduce myself, standing in front of his desk. He's sitting there looking up at me. What can I do for you?

I said, well, I'm really interested. Are you here to bring computers to the field of management? And he said in Forrester deep voice, well, no, not really. I'm really here to bring systems to management. Not having a clue as to what he meant, I said, oh, really, of course. And how are you going to be doing it? Well, it's to be seen what we're going to do. But I think we'll be doing some computer modeling work to bring a systems view of management issues.

And I nodded, totally blank as to what he really meant, but pretending to understand this. And he said, so, you are in Course 6? And I said, yes. And he said, what kind of courses are you taking? And I was busy thinking, what am I taking that relates to what this guy possibly could be interested in?

And I said, well, among other things, I'm taking the switching circuits. He says, from Sam Caldwell? And I said, well, yes, Professor Caldwell is my professor in switching circuits. And he says, he's a very good friend of mine. How are you doing in that course? And I said, well, I think I'm getting an A. He said, good. Good. Well, that's very interesting. Thank you for coming in.

And I said, being brash, I said, is it possible that I could come back and see you again next year when I'm in my senior year, and I'm going to have to be doing more thinking about career directions? And he said, certainly, I'd be glad to see you. So my introduction to Jay Forrester as a junior, without really having a clue as to what bringing systems to management was all about, turned out, in a way, to be really the turning point in my life.

And a year later, I came back, and I talked to him again. I had, in Course 6A, facing your senior year, a double assignment, back- to- back, two semesters in a row, just before you enter the full year of graduate school. And I was at General Electric, so I had two offers of jobs.

One was I could join the new GE Computer Division in Tucson, Arizona. And they agreed that they would fly me out there and back if I agreed to a double semester. That was a big deal that they would pay for the airfare. Or I could get a programming job in Small Aircraft Engine Division in Lynn.

Well, I already had a girlfriend, and I had all my student activities. And I really wanted desperately to stay in Lynn if I possibly could. By the way, the girlfriend is my wife of 52 years now. So it worked out.

And I said to Forrester that I'm really continuing to be interested in what you are doing. And I don't know when you're going to be hiring anybody, but perhaps there might be an opportunity for me to work in your group at some point. Would you give me any advice as to the kind of job I should take? And I described the two jobs.

He said, either job would be fine. They would both be good. But we're probably going to be doing some of our own computer software development, and it would be useful if you had programming skills. And I said, terrific. That was enough weaponry for me. I immediately went back to the 6A office, talked to Gene Boehne, who was the director of 6A, and said, Professor Forrester advises that I get this job in Lynn. And Boehne said, I'll take care of you, Ed.

And sure enough, I got my double assignment to be in Lynn, kept up all my activities, kept up my wife to be, maintained all of that. And then finished up that, did my graduate year in electrical engineering, finished my degree. By that time, Forrester was ready to move forward with System Dynamics. And he stubbornly insisted on hiring just graduate students from electrical engineering to join him. And he hired three of us.

So because, I think, of the prep work that I had done beginning in my junior year, I was one of the three fortunate graduate students in EE that Forrester selected. And beginning in the summer of 1958, I joined him as a full-time research assistant, and we started System Dynamics. Until then, he was working on his own. He was thinking about what it is he wanted to do. But except for writing one article in the *Harvard Business Review*, he hadn't really done anything to build a discipline or field and the like.

So we came in, and it was my first pioneering activity in a new field, the System Dynamics creation. In the beginning, it was Industrial Dynamics, and then we broadened our own perspective to not just industrial kinds of things. So that became a very important turning point in my life, because I was now working as a full-time research assistant for Forrester.

The terms and conditions of a full-time research assistant at MIT-- I think it's true throughout the Engineering School-- is that you can take two courses a semester free, and you get whatever the stipend is for a research assistant. So since I could take two courses, I could finish up all the credits I needed for my second Master's degree. And I finished that up very quickly. It took me a year. And I now had a Master's from Sloan as well as a Bachelor's and Master's from Electrical Engineering.

At that time, I seriously thought it was time to leave, because now I had a double education. I still thought I wanted to be an engineering manager. I now had new credentials in doing something very specific in bringing systems ideas from computers into management. And I thought about it, and then I decided that this was really an interesting thing that we were doing with System Dynamics and that maybe I should stay one more year. It would be a good investment of time just to help get this field further advanced before I went out looking for a job.

And that was my decision. I was going to stay one more year. Well, since I was going to stay one more year, I was still a full-time RA. I still had the right to take two courses a semester. So I didn't want to waste my time. I applied for the Economics Department PhD program. There was no PhD yet in the Sloan School, so I applied in Economics. I got accepted, and I started my PhD work in the Economics Department.

And once I started in the Economics Department, I opened up for myself a very different world. The quality of scholarship and academic excitement in the Economics Department, particularly in the Economics Department of Paul Samuelson and Bob Solow and the likes of who their colleagues were, was just dramatically exciting. And I think that in a very quick period of time, I fell in love with the exposure of academia. And after entry into the PhD program, I decided that I was interested in becoming a faculty member, not before.

And I'm quite sure that that is not like most people's lives. I think that most people who become professors have decided earlier on in their life that this is something they want to do. Not in my case. I decided after I was exposed to the excitement of such high-quality academics who were so stimulating in their attitudes.

I have, by the way, always felt obligated not just to Jay Forrester for what he did in System Dynamics but to Bob Solow. Bob Solow became the chair of my doctoral program. He was going to become the chair of my dissertation committee. And then he left MIT to join the Kennedy Council of Economic Advisers.

I went into total crisis when that happened. I went running into his office. I was sure that I was destroyed. And he told me to calm down and relax and that I ought to go see Frank Fisher, who was a new junior faculty member.

And Frank was an econometrician. I said, Frank will kill me. I can't do that kind of stuff. He says, stop being panicked. Go see Frank Fisher, and get out of my office.

And I went to see Fisher, and I ended up doing my dissertation with him very quickly. And I was done with my academic studies. Lots of other things happened in between, but that's my educational track through MIT.

**INTERVIEWER:** So I just want to follow up a little bit on your work in economics. Names like Samuelson and Solow, those are legendary names for people, not just at MIT, obviously, all over the world. You worked with them. You knew them at the height of their career. What was it like working with them? What were they like as people?

**ROBERTS:** Well, Samuelson taught the doctoral course in economic theory. And it was a required course, so all of the students in the class were PhD students. It was never a large department, so a class with Samuelson might have been 15 students. So you really were having a personal encounter with the man.

Samuelson seldom taught economic theory. He mostly taught the history of ideas. And whatever the topic was he was supposed to be lecturing on, he would end up spending 2/3 of the time talking about the background of the economist who had come up with this idea and that this guy came out of a poor family in Manchester, England, and his background-- and you were dealing not with learning something that was mathematical, which is what he was supposedly teaching. His attitude, I think, was you can learn that stuff on your own. What I'm going to tell you is I'm going to tell you what inspired that stuff.

And it was fascinating to sit with him when after Solow joined the Council of Economic Advisers, Samuelson remained fully at MIT but was an adviser to the council. He never took a position. Samuelson would go down for council meetings in Washington.

When Samuelson would go down to Washington, his doctoral assistant would teach our class. The doctoral assistant would come in and say, okay, now that Samuelson's gone, I can teach you this stuff on which you're going to be examined in the PhD general exams. And he would teach us all of the routine technical stuff. So Samuelson was an inspirer and was somebody who was laying a philosophical base for you to understand why you were interested in what was going on.

Solow, being Samuelson's student and close colleague all along, Solow was a workman. Solow did his stuff. Solow was the only person in the Economics Department that had a sense about technology. Solow got his Nobel Prize for developing a theory of economic growth and a model of economic growth that included technology as a contributing variable to economic growth.

Consequently, Solow was the guy who, both for his attitudes and his manner as well as for the substantive interest he had in technology, to whom I was most attracted, because it turns out what I wanted to do is I wanted to do my dissertation on applying System Dynamics to the field of research and development. By the way, Forrester said I shouldn't do it. Forrester said I should do something that was routine in production distribution systems, which everybody else was doing in System Dynamics. And I said, boring. And I wanted to do this.

Forrester said what I wanted to do was too hard and that I shouldn't try to do it. I went to see Solow. Solow encouraged me, because Solow liked technology, and he thought that trying to model technology at the level that I wanted to do it was intriguing and challenging. So I basically wrote my doctoral proposal. Solow quickly approved it.

Forrester was very reluctant, but it took me, I think, three more months to get Forrester to approve my dissertation proposal. But the Economics Department wouldn't allow Forrester to chair my committee. They would only allow somebody from the Economics Department to be chair of my committee. Forrester was a member of my committee. But Bob Solow, and then Frank Fisher as substitute, was that.

But I think that the environment then-- and I can only by imagination think that the same environment exists today-- was so stimulating and demanding. The most impressive course that I took in economics was the doctoral seminar, the PhD seminar. The PhD seminar was only for students who were at the point of a dissertation proposal.

And what you were going to do in the seminar is you were going to get up in class one day, you were going to present your proposal to your joint PhD students to hear, react, question, challenge, and the like. But the class was run by two faculty, Bob Solow and Frank Fisher in my year. The two faculty sat in chairs in opposite corners of the front of the room with the blackboard in the middle.

And the environment was crossfire, that you would be getting up in the middle, trying to present your ideas, your fellow doctoral students are out in front of you, and these two big guns are shooting the guns concurrently. And to me, it was really a bit like the debate experience I had had as an undergraduate but on a much more challenging level, because in debating, everybody is much more polite. You have your chance to present, and then somebody comes up to argue against you.

Here, the arguments were concurrent. And when the arguments were tough questions coming from the side, and you're looking this way, and then you're looking that way, you say, wow, this is really a storm of fire. And I think that what they did in the Economics Department was that they produced people who became accustomed to seeing ideas as things that deserved a storm of fire, and that ideas were fragile, and ideas were always in development stage, and ideas were something you had, but other people had perspectives on them and the like.

That kind of attitude of, in a way, projection and then counter with everybody around you was an absolutely stimulating set of challenges that I had not experienced as an undergraduate or graduate student in electrical or as a graduate student in Sloan. The environment then-- and I think less true today-- I think the environment then was much more learning from the front of the class to the back of the class, that the teaching was being done by professor to student.

And in the doctoral program in economics, that was not the feeling. The feeling was that the teaching was dramatically interactive, involving all of the doctoral students, involving professors in a collegial fashion. Now, collegial, but very challenging. There's no question who were the bosses. But they were there to fight around issues of ideas. And to me, that was an absolutely wonderful and inspiring situation.

And that's what caused me to change what I wanted to be in life. I went from thinking I wanted to be an engineering manager to suddenly knowing that I wanted to be a professor, and frankly, that I wanted to carry into the classroom what I thought I had learned-- not substantively-- what I had learned from a process point of view by my encounters in the Economics Department.

I must tell you that one of the most satisfying things I have done was a year ago, when they were raising funding for the Bob Solow Chair, the fact that I had an opportunity to contribute financially to creating a Robert Solow Chair was something that caused me to have great personal satisfaction. It was a small way of give back to somebody who had not just inspired me but who had taught me so much that I took with me for the rest of my life.

**INTERVIEWER:** So we'll be transitioning to the joining the faculty in just a moment. I'm curious if you could tell me just a little bit about System Dynamics and what you found appealing and powerful about that approach as a student and then sort of transitioning into your doctoral work and beyond.

**ROBERTS:**

Right. So when we started System Dynamics-- and it really was we-- when we started it in the summer of '58, there wasn't a field. There was a point of view by Forrester. The point of view was very clear, but we couldn't understand what in the world it meant. The point of view was that all important kinds of things in the world are embedded in feedback systems and that what you really need to do to gain understanding of behavior and of what is going to be taking place over time and of how you could intervene to alter behavior is that you had to explicitly search out, describe, graphically display, and represent the underlying feedback system structure that explained the behavior.

Now, very importantly, there was no feedback systems work in the social sciences at that time, nothing in management, nothing in economics, nothing in humanities. You could find some article 100 years earlier where somebody had mentioned the feedback loop, but nobody was doing rigorous work to analyze complex problems or situations or economies from that point of view. So that's what we were going to do.

Forrester was very insistent that electrical engineering graduate students were the ones that he trusted most to do it. A couple of years later, when I became a junior faculty member, I would argue with him. And I would say, Jay, you can go to mechanical. You can go to chemical. Those guys have the same kinds of feedback systems training.

And he would say, no, no, electrical engineering is where it's at. Now, whether that was only his own view-- when he came to MIT, pre-World War II, he worked in the MIT Servomechanisms Laboratory, servomechanisms is feedback systems. So Jay worked in what was the MIT pioneering laboratory of building feedback system oriented control devices. And inevitably, that was the basis for his mentality. And that's what we, as the diligent followers and builders of the faith, took on.

And it was not obvious. And the models we built were not obvious. But boy, we could build feedback systems models of anything under the sun. And we did. We had a whole bunch of graduate students on the fifth floor of the old Sloan building, which is where we were located. Forrester had a nice office on the fourth floor. The graduate students were on the fifth floor, out the back, looking at the parking lot.

And for fun, we would throw out a problem to ourselves and argue as to how we could go about representing this problem from a feedback systems point of view. And our attitude was that there wasn't any kind of problem we couldn't tackle. And no problem was more demanding than something that we could build a model for over the weekend.

And in a way, I think it's typical of MIT arrogant graduate students, and we certainly qualified. But we had a lot of fun, and we would be showing to ourselves how this notion could be applied to every kind of problem under the sun. I remember when one of the problems we decided to tackle was diabetes. Now, what in the world did diabetes have to do with the kinds of things going on in the Sloan School at that time? Answer, nothing, except to us. This would be a neat kind of thing to show students, that we can take the same kind of modeling approach and apply it to human dynamic systems.

And the system of blood sugar regulation with glucose and insulin and what have you is indeed a very good example of a feedback system. And we modeled it. And we could get our models to behave just the same way the diabetic processes worked in the human body. And we didn't regard it as a great invention. We regarded it as neat stuff for us to show our graduate students in our courses just as a way of indicating the power of the way of thinking about this.

Well, what happened is that within the System Dynamics Group-- and it was still the Industrial Dynamics Group for about four or five years before we changed our name-- within the group, we took on a series of sponsored projects. We had a project with Sprague Electric. We had a project with Minute Maid orange juice before they became a division of Coca-Cola. We had projects with Cummins Engine. And all of these were industrial projects, production, distribution, organization with inventories.

And in a way, it was the same kinds of problem sets that other people in the field of operations research and management science were tackling. And they were tackling it from their point of view. We were tackling it from a feedback systems point of view. Our models didn't look like their models. And we were looking for different kinds of understanding.

Well, gradually, we started reaching out to more complicated problems, to issues that were very different issues. When I mentioned earlier to you that I got into an argument with Forrester about my own doctoral dissertation, he wanted me to continue doing something like that. And by that time, by 1960 when I was picking a dissertation idea, I said continuing to do work like that was trivial and boring.

And I didn't want to do it. I wanted to do something new and different. And four semesters at General Electric and Co-Op and two degrees from MIT in electrical engineering caused me to feel comfortable with trying to model what went on in a technical environment. So I wanted to model engineering organizations and engineering projects. And Forrester said, it's too hard. You're not going to be able to finish your dissertation. And I said, I'll be totally bored if I do the other thing. This is what I want to do. And I did.

So my doctoral dissertation was *The Dynamics of Research and Development*. That became my first book. And it also became my entree to the second pioneering activity I engaged in at MIT, which was to get involved, from System Dynamics as my starting point, but as the target area of managing research, development and technical innovation. And there's no question I would not have got involved in it had I not been focusing my System Dynamics work on managing technology and R&D.

So that was our group. There was a fundamental problem. The fundamental problem was that Forrester was an engineer. And what that meant was that he didn't approach problems with the same acceptance of other academics and other scholars that most people in the management sciences field did. So Forrester's view was-- I remember once pointing out in a draft article.

I said, well, Jay, you should footnote such and such, and you should footnote such and such. And he said, no. Footnoting somebody means that I'm recommending that they read that person's work. And I said, no, footnoting somebody means that you're acknowledging that someone has done relevant work in the field. And he said, that may be your view of what it means. That's not what it means to me.

Well, his attitude was one that upset lots of other people. And consequently, from a brand new idea, which is what Industrial Dynamics was. It was a brand new idea where in the environment of the management sciences at the time in the early '60s, where it would have been, I believe, accepted as a bold new idea, instead, it became treated as a very controversial way of doing things, because, in fact, Forrester was very clear he didn't know about the other approaches, and he didn't respect all the other approaches.

So we ended up building an isolate field. And even today, which is now 50 years later, System Dynamics stands alone as a separated area. It is not integrated into management science departments or operations research centers at MIT or other places. It's a standalone practice.

And the people who do System Dynamics-- and those people exist all over the world-- they see themselves as very independent people. And they always can very clearly define what it is they do. And they aren't computer model builders. They are people bringing feedback systems points of view to attacking management, economic, social systems-- whatever it is that they're working on, they are bringing feedback systems to that field.

And in a way, it's a strength. But I think, more importantly, it's a weakness that we didn't have the advantage of being accepted as the kind of leadership thinking process that I believe we really were. And Forrester has received, belatedly, increasing amounts of credits and increasing numbers of professional society awards. But he's a man in his 90s at this stage. And from my perspective, it's a shame that he didn't have the same level of recognition and more 20 years earlier or sooner, because indeed, System Dynamics was really quite pioneering.

And I learned an awful lot from doing it. The long-lasting aspect of it, personally, is that I think differently. I can sit in a conversation with somebody, listening to them discussing life or their company, and I will hear from a feedback systems point of view. And I will be listening to ideas, and I will be looking for the cause and effect feedback loops that are explaining the ideas that someone is saying. And I think that all of the kinds of students that we trained well do the same thing. And to me, that's really a very powerful contributor.

**INTERVIEWER:** So tell me a bit about joining the faculty, making that transition, and how your interests involved from that point.

**ROBERTS:** Well, joining the faculty was a surprise. What happened was that in 1961, while I was already a doctoral student in economics but still principally doing System Dynamics work, in 1961, NASA was formed. And the head of NASA somehow decided that he wanted to have a relationship with MIT.

And he called Julie Stratton, who was president of MIT, met with him in Washington, and told him he wanted to create a relationship between NASA and MIT. Stratton called Howard Johnson, who at that time was dean of the Sloan School. Told Howard, go down and talk to this guy Webb and see what he really wants. And just remember, we don't do consulting for government agencies. If we relate, we do research.

Howard Johnson went down, told him that we would only consider a research relationship, that idea was welcomed, and in the summer of '61, a task force was appointed to the head of NASA. The task force consisted of the deputy dean of the Sloan School, who had been a Sloan Fellow from the Air Force and knew big systems; a major consultant, who was a senior lecturer in the Sloan School, who had been a McKinsey consultant on large organizations; Don Marquis, who had just come in to the Sloan School, who had been head of psychology at Yale and at Michigan, and therefore, had created lots of research centers; and me.

I was 25 years old. I was a doctoral student. I was a full-time instructor at the time. I'd been promoted, so I was a full-time instructor. But of the four of us, I was the only one who had any experience relating to engineering or R&D or anything to do with technology. The other three had never had any experience, nor was there anyone else in the Sloan School who worked on issues of technology or innovation in 1961.

So the kid, me, and these three very senior guys spent the summer touring NASA installations. We spent time in Washington. We spent time in Goddard Space Flight Center. We spent time at Huntsville, Alabama with the von Braun team. And in September, we put together a research proposal to NASA that said that we wanted to create a research center at MIT to look at the problems of large-scale technology management systems, especially those relating government and industry. That was our proposal.

We asked for an enormous amount of money. We asked for \$550,000 for 18 months. This was September, 1961. The headquarters staff at NASA thought that the amount of money was outrageous and kept delaying acting on our proposal. In February of '62-- it took five months-- Webb finally got annoyed with his staff and said, I want to move forward. I'm signing off on this proposal.

And in February of '62, we started the first research center in any university in America in the area of management of technological innovation. And it was NASA's first money into MIT. And it was the first research center of any field in the Sloan School. So we really were doing all kinds of novel stuff.

By the way, two years later-- and this is important, because it comes to entrepreneurship-- two years later, NASA established the first aerospace research center in the country. That was in the Aeronautics Department. It wasn't yet Aeronautics and Aerospace. It was the Aeronautics Department at MIT. So we ended up with two NASA centers on campus at MIT.

But we started that, and beginning in February '62, I now was splitting my work. I was doing System Dynamics. I was, in fact, in charge of all System Dynamics education at the time. Jay Forrester didn't like teaching. He liked to do big ideas, but he didn't like teaching.

So I was in charge of all the teaching. We had lots of students. And I suddenly was trying to contribute to beginning a new area of work, which was organizational management of research and development and technological innovation. And that was a new, very important area of excitement.

But to get back to your question, at the end of the summer of '61, when we had just finished our task force, Howard Johnson called me and said, come on down, Ed. I want to talk to you. And I walked into his office, and he said, I hear all about the great work that's going on in your task force with NASA. It sounds like it's really terrific.

And I said, well, it's really interesting and exciting. He said, I want to tell you that we have decided to make you an assistant professor. And I said, what? He said, we're appointing you an assistant professor. I said, wow. That's astonishing. And that's amazing to me.

He said, well, why are you so amazed? You're finishing your dissertation. And I said, well, not so fast. I said, I'm finishing it, I hope. But it's going to be at least another year. And Howard Johnson looked at me. He said, it doesn't matter. You're doing really good and exciting work, and we are delighted to have you as a faculty member in the Sloan School.

When I was in Florida this week talking to the MIT Club of Naples, the guy who introduced me started to grill me in advance of the session. He said, I've looked at your CV. There's something very puzzling. I said, what is that? He said, you became a faculty member before you got your PhD. I said, that's very interesting. You have good eyesight. I said, that's precisely correct. I became a faculty member a year before I got my PhD.

So I started as a faculty member. But to me, it was really quite continuous. I wasn't doing anything new as an assistant professor, except I got a raise, and I had a new title. But what I had was I had the continuing work in System Dynamics and now the new work in research and development management. So that became my official entry into the world of academia at the assistant professor level.

Now, I think had I had any hesitation about what my career choice was going to be-- which I think by then, I didn't. I think I really had this feeling that I wanted to be a professor. That clearly just put the nails into it and said, okay, that's what you are. And that's what I started.

**INTERVIEWER:** So you were asked to join the faculty, I guess the term is ABD, All But Dissertation

**ROBERTS:** Right. It took one more year.

**INTERVIEWER:** Right. One more year. So tell me a little bit about those years after you became an assistant professor, how your research interests developed, whether your life changed, other than getting the salary bump.

**ROBERTS:** Yeah. I had already been married. I got married in 1959. Nancy finished her Bachelor's degree at BU, and one week later, we were married. It was characteristic of that time period. She was 21. I was 23. So she was teaching when I became an assistant professor.

She was teaching sixth grade in Sharon, which is where we lived. And we stayed there until she was pregnant with our second child. And then we moved to Newton, probably 1963, a couple of years into my assistant professorship.

So what I started to do is to follow a dual path, that I continued to do System Dynamics work. And I continued to have a number of research projects building out different kinds of System Dynamics models. We launched one of the earliest two-week summer programs at MIT. "We" clearly was really "we." Forrester wanted this to be done, but I ran them.

Forrester was a great leader. He was not a great administrator. I always was curious about how he ran Division 6 at Lincoln Lab, which had, I don't know, thousands of people. He must have had very good direct reports handling stuff. But he was a phenomenal conceptualizer, and we built out a very effective summer program. So we were attracting industry to come into MIT in the summertime. We also had academics.

So we were building that field. And now we were starting from scratch with a new field. And the new field was beginning effective February of 1962 with the formation of our NASA-funded research project. We didn't really know what we were doing in that. It was an open-ended area. There was not an academic field of research on the management of research and development. So we created it.

We were biased at the outset in terms of looking for students who had had technical background and who were now trying to get doctoral degrees in management or in economics. The Sloan School at just about that time got authorization for its own PhD program. So now we had, in a sense, two local feeder departments, either economics or management. And we began looking for people from the outside world who had comparable backgrounds, because our sense was that if you had a technical background or at least study, if not also work, you would have a better opportunity to understand what really was taking place in engineers and scientists doing work, carrying out activities in the organization structure and the like.

And gradually, we evolved a large number of research programs, hired in a number of very productive people. The first real hire who joined our group, Don Marquis was my boss, the one who was part of this original team. Don was a distinguished psychologist.

But Don didn't know anything about technical organizations at all, but he was a great inspirer of graduate students and junior faculty. He was terrific in helping them to figure out what they wanted to be doing on their own, despite having no real world experience in the area. So he was great.

I was associate director of this new organization that had nothing in it except for money. We had this great amount of money. We had \$550,000 that was supposed to last us 18 months. Well, the short of the money was that the money ran short. We ran out of the money at about 12 months. Fortunately, Jim Webb was still head of NASA. He gave us some more money. By that time, we got some Air Force money. We started building an organization.

The first PhD student at we recruited into join us was Tom Allen. Tom Allen is now Emeritus, but still a faculty member at MIT. So Tom was my closest long-term colleague in the area of managing technology and innovation. And we really worked together closely for a very large part of the last 50 years. Recently, he runs two interdisciplinary programs between engineering and Sloan. He runs the Systems Management program, and he runs the Leaders for Global Operations. And he's the administrative guy in charge of both those programs.

But we started, and we gradually built out a faculty. As we built a faculty, we started building courses. And I think what we did was, in a way, routine from a process point of view, but totally innovative from a content point of view, because nobody else was working in the area of managing technical people, managing technical groups, managing technical projects, managing technical organizations. Nobody was doing it. We were doing all of it and gradually building it.

Over time, we became more ambitious so that I think we took on bigger tasks. Someplace along there-- I'm trying to think about when. Probably 35 years ago, which would make it maybe in the mid-'70s, which is a long way from 1964. By the mid-'70s, we formed the first joint degree program at MIT. The Engineering School and the Sloan School jointly sponsored the Management of Technology Program.

The Management of Technology program was a one-year, mid-career program for people with technical backgrounds. And we described our mission, who aspired to positions of leadership and technical organizations. Now, initially, to leading the technical side of those organizations. But more broadly, to leading the organization overall.

So we started that program someplace in the mid-'70s. We gradually built it so that it was a full parallel of the MIT Sloan Fellows Program, which had been the pioneering executive development program started in the mid-'30s. And about seven years ago, the two programs merged. At the time, the MOT program was maybe 60 students a year. The Sloan Fellows Program, we're now 50 so we bypassed it, which is interesting.

That also got us into entrepreneurship in the sense of students coming in who were entrepreneurially- oriented. But that's an aside. But that was a really exciting activity. And it was the first time that engineering faculty and Sloan faculty were co-teaching in the same program. We had approval by every department of the Engineering School to both admit students and award degrees. So this was truly jointly done.

We had an advisory board that included three Engineering School department heads, as well as people from Sloan. So it was really quite an interesting activity and I think probably taught me the important benefits at MIT of cross-campus collaboration. I had that instinct because of the fact that I came through Electrical Engineering and into Management and then Economics. So I had degrees from three Schools of MIT.

So I sort of felt collaborative in my own attitudes. But when we launched a program where we could actually pull it off, and where we had side-by-side faculty contributors who were, in many cases, co-teaching, where we would have a faculty member from Civil Engineering and a faculty member from the Sloan School staffing the same class and bringing different perspectives on the same broad aspects of content, that really was, to me, a wonderful experience. And it was quite effective from the student point of view.

So I think I got even more indoctrinated than I had been as a student in the notion that when you can try to link across the campus and bring especially the technical side of the campus together with the management side of the campus that there's all kinds of wonderful things that can be accomplished. And that, by the way, is the heartland of what we do in the entrepreneurship program, that we try to manifest that point of view. But I would say that we just basically kept building out the management of technical innovation heavily at the organization level.

Now, I didn't know anything about organizational research. I hadn't studied it in any meaningful way. I think I took probably a couple of courses while I was a Sloan Master's student on the organizational side. But there, the help of somebody else was very important. Don Marquis was a distinguished social scientist, and he was my boss. And he certainly never behaved like a boss. He always behaved as the warmest of colleagues. But he knew things that were quite different from what I knew.

And the illustration that is the best one to give relates to how we got started in entrepreneurship. And I'm sure you'd be interested in that. I mentioned to you that NASA started its first aerospace research center on the campus in the Aeronautics department.

About a year or so after that center was started, Don Marquis got a telephone call from the senior faculty member in aeronautics who was heading the NASA Aerospace Research Center. And the call was, I'm having some problems politically with NASA headquarters. I have a feeling that maybe you guys might be able to help me with it. Could you come and chat with me about my problem?

So Don said, Ed, why don't you come with me? I was associate director. We walked across campus down to Mass Avenue to where the aero department was, went in to talk to this gentleman, and he told us his problem. The problem was NASA headquarters was pressuring him to carry out some research that showed that NASA-sponsored research had social benefits and that without having the words invented, essentially, that somehow what they were doing would generate technology transfer.

Well, Marquis and I heard this. He said, nobody in my department could do anything on this. Maybe somebody down your way could do some research. We'll fund it if you can go find somebody.

And Don and I spent an hour brainstorming with this gentleman from aeronautics. We tried to think about everybody in the Sloan School. And we went through them mentally and tried to imagine what kind of research each faculty member might be willing to do that could possibly contribute to the Aerospace Research Center's political problems. And we struck out.

An hour or so is gone. We are now apologizing that we haven't been able to help. We're getting up, putting on our coats to leave, to walk back with apologies that we weren't able to assist him.

And I'm now standing there. This is September, 1964. So I'm now a third-year assistant professor. And I'm standing up putting on my coat, and I turn to him, and I say, can I ask you a dumb question? And he says, shoot. I said, don't I understand that people leave your laboratories to set up new companies? And he said, oh, yes. Many do.

I said, well, if they leave your labs to set up companies, don't they take with them ideas, developments, that they worked on while in your lab? He said, absolutely. I said, well, I don't know what I'm talking about, but it would seem to me that at least some of those people are taking what's coming out of NASA- and Air Force-sponsored research and bringing them out to the market in what their companies are doing.

He says, yes. I said, well, if you're interested, I think that's a really interesting kind of phenomenon, and I would be interested in studying the people who leave your labs to set up new companies. And I would trace the flow of technology from the work that they did at the Instrumentation Lab or wherever out to the market. I am positive that I would be able to demonstrate that there is significant movement of government-sponsored research to the market through the phenomenon of setting up new companies.

And he says, how much money do you need? This is the response. Marquis and I take off our coats, we sit down, and now the coaching comes in. Don says, Ed, put in a month of summer salary for yourself. Okay. This is 1964. Put in \$1,000 for computer time, because we paid rental on mainframe computers.

You want two research assistants. Put in salaries for two researchers assistants. Okay, I'll do that. Get in some travel money. Okay, got to figure all this. And then we're figuring out what was MIT overhead. I have no idea what it was at that time. Certainly not what it is today. Okay, figure it all out.

Then I turn to this professor and say, we'll need \$16,900 for one year. Could you imagine that? When you tell somebody today, those were 1964 numbers for just what I was describing, including a month of summer salary and two RAs and what have you. And he says, you've got the money when you get back to your office. Send me a paragraph.

And we walk out. We start walking back. Don Marquis turns to me, says, Ed, that's a terrific research idea for a new research project. How are you going to do it? And I said, Don, I don't have a clue. And he laughed, and he says, well, we'll figure it out somehow.

I went back to my office. I sat down. I now had a task. I had to get a paragraph to this professor in aeronautics. And to have a paragraph, I needed a title. So I came up with my title. And the title was, "The Transfer of Aerospace Research from Government Funding to the Market via the Formation and Growth of Technology-Based New Enterprises." Now, with a title like that, I only needed two more sentences and I had finished his paragraph.

And that was the beginning of entrepreneurship research at MIT in September of 1964. And it was funded by NASA via the Aeronautics Department, not the Sloan School. So the first money in came out of the Aerospace Research Center, transferred in to me as a faculty member in the NASA Organization Research Center in the School. So even then, it was a collaborative flow of funds.

And the first thing I did was I started to try to read the literature. Well, the literature on entrepreneurship in 1964 was garbage. It was literature about people who did restaurants and garages and what have you. It was dominated by failure.

And I read a book that I found called *The Entrepreneurial Man*. It was a study of entrepreneurs in the state of Michigan. The average entrepreneur in the state of Michigan had less than a high school education. Ninety percent of the entrepreneurs failed quickly. And I'm reading this, and I'm saying, oh my god, what have I gotten myself into, because look at this. Entrepreneurship is really terrible and negative and all this stuff.

And no one was studying the kinds of people I wanted to study. I wanted to study engineers out of the Instrumentation Lab who were setting up high-tech companies. And there was no literature on that.

So I kept reading. I hired a research assistant from Sloan, Herb Wainer. And he was my first research assistant. We started to figure out, how would we do this? What kind of questionnaire would we administer in face-to-face interviews with entrepreneurs if we could figure out who to talk to.

And when we thought we were ready, I made a phone call. The phone call I made was to Stark Draper. Stark Draper was department head of Aeronautics, and Stark Draper was head of the MIT Instrumentation Laboratory.

And I called him up, and I said, Professor Draper, my name is Ed Roberts. I'm an assistant professor in the Sloan School. Your professor, whatever his name was, has funded me to do a study of technology transfer via people who leave laboratories to set up new companies. And I would like to know if we could go and study the people who have come out of the MIT Instrumentation Lab.

And on the telephone, Draper said to me, entrepreneurs are the most important people in the world. Entrepreneurs are the ones who change the world for the better. Entrepreneurs are the ones that I value most in my laboratory. When can you get here?

Not what I expected as a greeting, because as a junior faculty member, you don't assume that you're going to suddenly find a red carpet. And we made an appointment. I had my research assistant. We went over to the I Lab.

We walked in-- this was probably five days after I had talked to Draper on the phone. Draper had assembled his entire senior staff to meet with us. Draper's assistant, who was running the operations in the lab, was there. Draper's senior human relations person, who was in charge of personnel for 15 years, was there.

Draper introduced us with the same kind of announcement to everybody else that he had made to me on the telephone. I regard entrepreneurs as the most vital people that's here, and Professor Roberts-- there it was, a professor-- Professor Roberts wants to come and study our people and how our people have gone out and what they have done. And I want all of you to cooperate to the fullest extent to helping him carry out this study.

Now, in the meantime, I've asked Bernie-- whatever his name was, who was his right-hand guy-- to look into this and to see what information we could give you to help move this along. And he says, we have-- and he points to his human resources person-- we've pulled together 39 names for you of people we believe have left the laboratory to set up new companies. And we've got as much information as we can muster out of our files. But we want to give you a head start on this.

And we start to talk about our criteria we only wanted full-time people. We didn't want graduate students. We didn't want assigned Air Force officers. We wanted just full employees. Why? Those were our decisions as to what we wanted.

We wanted people who had formed for-profit companies. We didn't want people who started new products in existing firms. They had to be real founders. We told them all this stuff. Okay, well, there's some things you probably will throw out.

And then he looks at me, and he looks at my research assistant, and he said, what kind of resources do you have working on this? And I said, well, your colleague has given us \$16,900. And I've hired Herb Wainer to work with me. He turns to his assistant, Bernie, says, we have to have a lot of graduate students working for us who would rather work for Roberts than work for us. You find him somebody good and add him to his staff on our budget so that he has something more to work on.

And this was an absolutely astonishing beginning. So we started from there. We started studying the spin-offs from the instrumentation lab. We ended up developing our research protocols and the way we would do the research and how we would gather additional data.

We ended every interview by saying, do you know of anybody else who ever worked with you or at the lab who might have participated in forming a new company? That's called a snowball technique. So you start with a kernel, and you try to build on it.

And in the end, we completed a very impressive first study of all the spin-offs from the Instrumentation Lab. Well, okay, now I'm ready to go on. I called the director of Lincoln Lab. And I told the director of Lincoln Lab who I was, that we'd now finished a study, just about done, at Instrumentation. We wanted to replicate our study.

And the director of Lincoln Lab says, entrepreneurs are the most useless people that I've ever encountered. They are troublesome. They get in the way. They contribute nothing toward our mission. I have no interest in you disrupting my laboratory by coming in and talking to people. Thank you. Goodbye. Whew!

So I was trying to figure out, how do we deal with that? Well, I made one phone call. My phone call was to the vice president of sponsored research of MIT. And I told the vice president of research as to how we had been treated at the I Lab. And how we were responded to at Lincoln Lab and that I really suspected that Jim Webb, who was our primary NASA sponsor and the head of NASA, that he wouldn't be thrilled to hear that a major laboratory at MIT doesn't want to participate in forwarding his mission in this way.

And whoever was the VP of R&D at the time for MIT said, let me get back to you. And two days later, I had a call from Lincoln Laboratories saying that, we've been thinking about it, and we've decided that we'd be happy to work with you on this.

So we started from there. Over the years, we covered every major laboratory at MIT. I took the big labs, most of them in Course 6. You had the biggest lab, Electronic Systems Lab, Research Lab for Electronics, heavily Course 6 based, but somewhat interdisciplinary. Certainly there was physics. There was some mechanical.

And then I started going away from MIT labs. I started studying MIT departments. I studied physics. I studied biology. I studied chemistry. I studied all the engineering departments.

Then I got tired of all that. I decided I needed to study outside organizations. So I started studying government laboratories in the area. I then went to industry, started studying industry spin-off companies. All of this is now evolving a program over years and years. So we are now taking more and more time and growing in the dimensions of work and the like.

Then I would have graduate students coming in, and they want to do a-- in those days, to get a Master's degree, you needed to do a thesis. I would have students coming in saying hey, I'd like to do a thesis on entrepreneurship. And my first question would be, what do you know? And they would say, well, I got a bachelor's and master's in mechanical engineering from Drexel. And then I worked for two years for this company doing this.

And I would say something like, how would you like to do a study of companies founded based upon mechanical technologies? Oh, that'd be good. Because you would understand the work and what they're telling you about. And yet, you could take our approach and our questionnaire-- by that time, we had really refined questionnaires. All the interview techniques were careful. We knew how to do the statistical analyses and the like. So we would have all of these students coming in by field, replicating the research study.

Over a period of 20 years, we carried out studies on hundreds and hundreds of entrepreneurs. We did probably 40 to 50 studies separately, all of which got embedded in my 1990 book. The purpose of my 1990 book, *Entrepreneurs and High Technology: Lessons From MIT and Beyond*-- because it truly was heavily MIT but and beyond, because we went into one after another field of technology, the technologies that today, you would say are the modern fields. But they were modern fields 30 years ago.

So I was studying advanced energy technology companies. I was studying advanced materials companies. Today, you would do exactly the same thing, and you would label them almost the same today. You might say nanotechnology instead of advanced materials.

So we did all that. The real purpose of my 1990 book was I wanted to change the view of people about the field of entrepreneurship. I wanted people to feel that entrepreneurship was, in fact, an area in which there was an organized body of knowledge, that that organized body of knowledge, in fact, had lessons, and that you could learn things from those lessons about how to found and build companies towards more successful outcomes. So the title of the book was explicitly, what were my goals, lessons, from MIT and beyond?

In 1990, if somebody goes back and does a literature review and looks at what was the state of the art of literature in high technology entrepreneurship, they would find that there was just about no literature. I knew all the people in the country who had by then started doing work in the field.

There were probably two or three other people around the United States-- by the way, nobody at Stanford, yet-- now Stanford has a very good group. At that time, there was a guy from Indiana studying Silicon Valley. There was nobody from Silicon Valley studying Silicon Valley.

So you had a nonexistent field of study. As a field of practice, people have been entrepreneurs for thousands and thousands of years. But as a field of research and organized knowledge, the field didn't exist. So to me, this was, again, a really exciting enterprise of my own.

At the time I started-- 1964-- I had just started my own first company. Now, my own first company was a consulting company in System Dynamics. And it came from my frustration that System Dynamics was too academic and not adequately practical.

So I approached one of the other two guys that came from Electrical Engineering with me, Jack Pugh-- Jack was a doctoral student and a research associate at the time. And I convinced Jack Pugh that in order to make System Dynamics practical, we needed to have a company that was going to help the outside world to do System Dynamics. We needed to consult for large government organizations and large companies to help them to do Systems Dynamics work.

And Jack agreed, and we started Pugh-Roberts Associates as a System Dynamics consulting firm. That was '63. In '64, we were already well underway in our R&D management. So lo and behold, instead of getting jobs coming in just to help people with modeling, I was having people say, but we'd like you to help us with our organization of research and development, and in particular, with how we're transferring research results from corporate research labs into operating divisions, which became a specialty area of ours.

So gradually, Pugh-Roberts started to build. I was never full time. It was always the place where I did my consulting. As Pugh-Roberts started to build, and as we began hiring people-- we only hired MIT graduates. So we began building an organization of MIT graduates, largely, initially, System Dynamics people, and gradually moving into R&D management as well.

We built a two-divisional consulting company, one that did what we called strategic modeling-- System Dynamics-- and one that we did management of technology and innovation consulting. We ran that company. I was CEO and president. This is an issue today. In that time period, in the beginning, it wasn't an issue. It was okay.

But it was just a consulting company. We ran that company until 1990-- from 1963 to 1990. And in 1990, we sold the company to a very large British firm, PA Consulting Group, which had about 2,500 people worldwide and no MIT employees. So we gave them their first 45 MIT employees by their purchase of Pugh-Roberts Associates.

So I had started a company a year before I started research on entrepreneurship. One of the questions I ask of myself is, when was I really first interested in entrepreneurship? And I suspect that it comes out of working with my father. I suspect that. But I never suspected it in the sense of a positive feeling that I want to go build a big company.

My father never had more than one truck. There's a lot of jokes I could tell you, but I can tell you about when we ran a seminar on entrepreneurship in the United Arab Emirates, and I find myself talking in an executive session to a very tall, white-robed guy who tells me that he's in charge of ground transport for Aramco. And I said, you mean you're in charge of all trucking and railroad movement of fuel oil from sources out to destinations? And he says, yes, that's my role. And I said, my father was in the same business.

And he looks at me in shock. He says, really? Your father was in the same business? And I said, well, yes. He said, how big was his business? As I said, for most of his business career, he had one truck of 600 gallons. But before he retired, he went up to 1,000 gallons.

And this guy laughed. He laughed. He thought it was the funniest thing imaginable. And then he paused, and he looked at me. He said, in principle, they're the same business.

So did working on the truck as a kid, did being picked up on winter days from school in grade school by my father rather than going to an activity-- I had to look out the window during a snowstorm to make sure in case my father had his truck parked near the school door, that meant I had to cut out after-school activities and quickly run out and get on the truck with my father.

And the first stop we would make is we would go to the wholesaler where he got his oil. And he would have in the truck what we called my "oil clothes." They would be in a bag so that I would take my school clothes off in the men's room, and I would fold up my school clothes to keep them clean. And I would put on my oil clothes, and I would work with my father the rest of the day.

And during World War II-- people today don't know anything about rationing and stamps. But we did. My sister and I would sit with my father at the kitchen table pasting stamps onto sheets to turn into the OPA, I think it was. I think it was the Office of Price Administration which regulated rationing.

I remember sitting with my father doing his books where we would discuss what was the average cost and what was the average price. And we would calculate it. We didn't have calculators. He would give my older sister a problem. Her problem was, okay, Charlotte, 2,550 gallons at 14.4 cents. And she'd be sitting there calculating.

And he'd say, Eddie-- and we would have range oil and fuel oil. And he would say, Eddie, 1,322 gallons at 12.5 cents. And I'd figure that. And my father frequently would be sitting there, and he would be doing some calculations. And then he would listen to us tell him what the answer was. And with a pen, he would write it into his ledger.

And he would double-check us periodically, one or the other. And if he found a mistake, he would say, this is not game playing. This is real. And you end up having a very different sense of the reality of business doing the trivial entry bookkeeping of a one-man business.

But my father didn't want me to be a businessman. He thought that what he wanted, he wanted me to go to MIT. He wanted me to become somebody who was a scholar. If anything, he had a stronger desire for me to become something like a professor than I did. I wanted an MIT education. But I think in his value system, he wanted me to be what, in a way, he would have loved to have been.

He was an immigrant. He came from Russia at age 20 to the United States in 1919. And I think that in the old traditions of small villages in Russia, he would probably have rather, as in whatever that play is-- *Fiddler on the Roof*. I think he would rather have had the bench on the eastern side of the synagogue where he could be a scholar than be out doing work in the oil business. And for him, to have his son do that was something that I think he valued. So I don't think that I really wanted to be an entrepreneur.

When I turned to Jack Pugh in '63 as a second-year assistant professor and said, Jack, we need to start a company, because otherwise, the world is not going to see that System Dynamics is really valuable and really important-- I persuaded him to start a company. He was not interested in being involved in a business. He was happy to stay at MIT the whole time.

So even then, in starting a first company, I don't think I had entrepreneurial drives. I think I had, in a way, academic drives. I wanted my academic field to be successful.

But somehow, there's something else there. Before I finished my PhD program, I was intrigued about entrepreneurship. I wasn't doing anything about it. But I was intrigued with it.

There were no courses in entrepreneurship at MIT. There was a course called Management of New Enterprises at the Harvard Business School. I called the lecturer who taught the course in Management of New Enterprises. I told him I was a doctoral student and a junior staff member at Sloan, and I'd be interested in coming over and sitting in on his class. And he said, well, what are you looking for? And I said, I guess I'm looking for generalizations about entrepreneurship.

He laughed on the phone and said, in my class, you'll find two generalizations. I said, okay. He said, number one, buy low, sell high. And he laughed, and I laughed. Number two, always take an option. Never give one. I said, okay.

And he said, so you want to learn generalizations, huh? And I said, well, I'd like to. He said, okay, you can sit in on my class provided that you come to see me at the end of the class, at the end of the semester, and tell me, what generalizations did you learn? I said, sounds like a good deal.

I took this class. End of the semester, I went to see him. And he said, okay, so what did you learn in my class? I said, well, I learned that you clearly are trying to convince your students how hard it is to be an entrepreneur. And he said, well, yes. But what else did you learn? I said, well, that's principally what I learned.

He said, well, when you say how hard it is-- I said, well, most of the cases you describe-- Harvard Business School standard, a case each class-- I said, most of the cases you described were failures. He said, what? I said, most of the cases were failures. He said, what do you mean most of the cases were failures?

I said, well, I don't know, you had three cases that were real successes. And I mentioned the three cases. And he said, well, what about-- and mentions three more. And I said, well, those were not terribly impressive. That was rather insignificant. And he looked at me, and he said, really?

I said, well, I don't know anything about this. That's how I perceived this, that that must be your main point, that students shouldn't go into entrepreneurship unless they're really dedicated, because by and large, they'll fail. He says, phew, maybe I need to review my cases that I'm using. Well, okay. Thank you very much. And that was it.

So my total formal education in entrepreneurship was this one course I sat in on the Harvard Business School, which clearly had not taught me very much. And I think that it was the excitement of getting involved with the research project funded by the MIT Aerospace Research Center that began to get me into repeated face-to-face encounters with highly stimulated, intelligent people who were taking on tough tasks, really focusing heavily on challenge.

I clearly formed many of my impressions about what is the character of the entrepreneurs I'm interested in. For the most part, they're not starting companies to make money. They're starting companies to overcome challenges. They're starting companies to solve a problem.

They're starting companies because they're frustrated by a boss who didn't pay attention to what they were advocating as being something fascinating and great. And their boss pooh-poohed the idea, or the boss wouldn't fund the idea. And they would quit wherever they were to go out, and it was an "I'll show him" attitude that was behind a lot of these companies.

One of the last questions we would ask in our interviews-- because I got interested in corporate entrepreneurship. How could a company be more entrepreneurial? One of the last questions we would ask is, what could your boss have done to have kept you in the organization rather than leaving? And we got a wide variety of answers. They could've funded me, could've done this, and the like. The most popular single answer was, if he quit, I would have stayed. And you really see the drive of the individual to do his own thing.

And I think that, whether it was months of that or years of that or what have you, that just drove me into a real sense of commitment, that being an entrepreneur has great value and can contribute wonderful kinds of things to society and can generate jobs and revenues and outcomes that are great and can produce huge amounts of satisfaction while they produce high levels of frustration as well. So I got hooked. And as a result, I started getting involved personally in a lot of startups and later on, once I had money, in funding companies, going on boards, and lots of other things.

**INTERVIEWER:** So there's an interesting thread here, which is the evolving perception that people-- and I mean the general public-- might have about what an entrepreneur is or who an entrepreneur is, the idea of the people starting a small business who fail, as opposed to people who are starting companies for almost idealistic reasons, to solve a problem, to attack something that they're engaged with intellectually. And I'm wondering if you could talk a little bit about that shift and how that shift manifested itself at MIT. Obviously, MIT is a very entrepreneurial place from the beginning, but we didn't necessarily use that term in quite the same way that it's used now. And you were obviously a key part of that.

**ROBERTS:** Yeah. First, I think it's important to realize the differences of who the people are that we relate to, that remember, in the first book that I read called *The Entrepreneurial Man*, we were dealing with people-- all the entrepreneurs of Michigan, average education, second year of high school. Typical company, restaurant, garage, service-oriented firm and the like.

At MIT, even in my early studies, average education, master's degree in engineering. Obviously, one or another of those degrees must have come from MIT or more highly educated people in a highly selective environment of people, in an environment in which the people around them are highly educated, have excellent access to knowledge, are contributors to knowledge, and the like. So I've always been fascinated and interested by, in a way, a different class of entrepreneurs than are, in fact, the run of the mill of small business entrepreneurship in America.

Frankly, for years, I've advocated getting rid of the Small Business Administration and changing it to the New Business Administration, because I don't see any value in "small." I see value in "new." This is a focus upon innovativeness.

And the kinds of companies that I'm interested in are companies started by people who are trying to do something new and novel. And after several years, it's not new anymore. And I would love to help them when what they're trying to do is new. I don't have any great motivation to help them once what they're trying to do is, in a sense, old hat and boring.

So once you get into an area that has now become routine, with no innovation, or little innovation, to me, the challenge is gone. And the challenge is in taking your own ideas, or somebody else's ideas, or working to create some ideas that are new and novel. Now, anytime you're doing that, you are trying to overcome a barrier. You're trying to jump a hurdle. You're trying to solve a problem, something that is there that is a challenge.

And the newness is required to overcome the challenge. That's where MIT comes in. MIT doesn't come in encouraging small business entrepreneurship. MIT comes in, in encouraging people to do innovative and challenging things. And when they manifest innovative and challenging things in the forming of a business activity, then they become founders of new businesses, what I call entrepreneurs.

Now, you can use the word "entrepreneur" any way you want. I mean it in only one way. I mean it that you participated as a founder of a new company. Now, by the way, I don't care if the new company is for profit or not profit. You're still a founder and an entrepreneur. We may segment what you then do in life. That's okay.

But in either situation, you're trying to take on something that is novel, presumably something that flows from the education you either brought with you into MIT or the education that came to you when you were here at MIT. It's something that could be taking place with faculty or staff. It's something that certainly takes place heavily-- and, by the way, numerically-- primarily with students and alumni.

So the data are very clear. MIT does a great job-- the greatest in the country-- of licensing technology coming out of MIT to startup companies. On average, over the last 10, 15 years, 25 new companies a year started with licensed technology from MIT, coming out of MIT research labs and heavy investment and the like. That's great. And it's number one in the United States, number one in the world. And 1,000 MIT alumni every year start companies.

So we're contrasting. 25 companies licensing technology from MIT coming from our labs out and 1,000 companies a year started by MIT alumni who have been educated here, groomed here, who came in really talented when they entered, more talented and better informed when they left, and hopefully we imparted to them a spirit that taking ideas forward in manifesting those ideas in some way. And I'm only studying now-- I'm only studying formation of new companies. I used to study formation of new products.

So I used to study innovation inside of existing organizations. And I studied what I called "internal entrepreneurs." I studied people in large firms that were behind the creation of new product divisions and new business lines and the like. And I found very strong similarities between the people who stayed in the large firm but did something new and novel and exciting and the people who left to do something new and novel and exciting on their own hook.

Now, I personally find it more interesting to be studying the ones that are going out on their own, in some ways, because it's even more difficult. You have to organize everything from scratch. You have to find the people to work with. You have to find the money. You have to find the market. You have to, yourself, assemble all the resources to make the whole job done.

If you were the initiator and internal entrepreneur inside a large firm, presumably, there's lots of other people around who are picking up on many of those tasks. Somebody else is providing you with the money. You may not like their decision making, but they're the ones who have that money available. If you're on your own, you're going to figure out who in the world is willing to invest in your crazy idea. Where do you find that person? What do you have to do to entice them into a financial relationship with you?

In a large firm, there's a marketing and sales organization. It may not be exactly ideal for what you want to do. That may be a problem. In your organization, there's no marketing and sales organization unless you've got a founding partner who brings those kinds of skills with you. If not, you'd better look for somebody to help you with those points of view. So I find the comparable challenge is that one would see in getting something new off the ground in an existing organization to be, in many ways, dwarfed by similar and related challenges that manifest itself in setting up a new company.

So over for the years-- for 30 years, I ran our Management of Technology and Innovation Group at Sloan, which was, by the way, the pioneering academic group in the world in the field. And we've been mimicked by lots of other places, but we were the pioneers. We did all of the stuff, beginning from the original NASA funding in 1962.

And then I took off on the entrepreneurship side as being the area that, by now, I've ended up as, in a way, the principal use of my time, that I now am no longer doing corporate innovation and corporate entrepreneurship. I'm doing new company startups and the like. But I said to you, I don't have any great thirst for sustaining small businesses, which the SBA does. I have great thirst, I think, that you could take every program being run by the Small Business Administration and by slight amendments of words, redirect it into dimensions that would promote far more significant economic growth and development in this country.

We have a big Small Business Innovation Research program where every government agency that carries out \$100 million or more of sponsored research is taxed. They have to set up a program to fund small business organizations. A small business organization is defined in magnitude of employees or dollars of revenues.

I would get rid of all of that. I would change it to the New Business Innovation Research Program. And I would have them pursue the same goals. But in order to qualify, I don't know, less than five years old, less than so many people, trying to do something that is really going to be significant and innovative. And today, in this country, when we are focused on issues of jobs and job creation and competition on a global basis, I really think that a relatively small shift of terminology, with whatever that shift would now do for you in your thinking process, could actually lead to dramatic changes in economic outcomes and economic benefits for the country.

**INTERVIEWER:** So let's talk a little bit about what is now known as the MIT Entrepreneurial Ecosystem.

**ROBERTS:** Right.

**INTERVIEWER:** There was a time when that concept would have been meaningless to people here.

**ROBERTS:** Correct.

**INTERVIEWER:** Let's talk about how that formed and why it's been successful, what its moving parts are.

**ROBERTS:**

Yeah. So first, it's clear, William Barton Rogers started it off. In 1861, somebody starting a university and saying its underlying theme is "Mens et Manus" was clearly a different kind of a person, somebody arguing that mind and hand to go together, that you want to create an institution that is going to generate useful knowledge, not just knowledge. That's a different place.

So that place evolved, and the place involved with hiring the faculty who believed in useful knowledge, in promoting people who were demonstrating useful knowledge. So you had "Mens et Manus" flowing. And it was flowing for 100 years. And in the process, you had all kinds of distinguished MIT faculty becoming entrepreneurs, starting companies.

So everybody remembers, or a lot of people remember, Arthur D. Little as a distinguished global technology consulting company. They don't know that Arthur Dehon Little was chairman of the chemistry department at MIT. They don't know that his feelings towards MIT were such that when he died, he willed the organization to MIT, which MIT then took and turned over to the employee trust of Arthur D. Little. Kept the building. The building is 30 Memorial Drive and has just become the headquarters building for the Sloan School Dean's Office and the like. It's now a beautiful building. It was a rat trap for many years.

But if you go look at this, you find a long history of people who were not doing anything institutionally unique but were behaving differently. And you can see it in all the old examples. Bolt, Beranek, and Newman were the Acoustics Lab, then became a consulting firm. And Bolt, Beranek and Newman became a lead acoustics firm.

To do underwater acoustics for the Navy to worry about submarines, they had to have a level of computing capability that was beyond what ordinary acoustics required. So Bolt, Beranek, and Newman, which became BBN Inc., became a center for very advanced computing technology and ended up that they-- not Al Gore-- invented and developed the internet. So ARPANET, funded by the DARPA-- the Defense Department Advanced Research Projects Agency-- funding BBN, an MIT spin-off in acoustics, created this special communications system in case of nuclear attack on the United States. It was a backup system for communicating, which became the internet.

Or you go to EG&G. Well, EG&G isn't letters. EG&G is people. Edgerton, Germeshausen, and Grier, Doc Edgerton, distinguished faculty member, pioneer, inventing high-speed light photography. Two research assistants, Germeshausen and Grier. Consulting firm. Consulting firm growing, because of wartime efforts, into a major, multi-billion dollar electronics company.

Then you go post-war, and you find, suddenly, it's no longer just professors, although some professors doing very interesting product stuff. Amar Bose, new generation of acoustics, trying to get better speakers because he liked better speakers, creating Bose Corporation, and not so incidentally, most recently, turning over the bulk of his stock to MIT as a donation so that MIT has become the majority stockholder of a multi-billion dollar great corporation.

Or you now turn to mere engineers coming out of MIT, like Harlan Anderson and Ken Olsen, who were working together at Lincoln Laboratory and took Lincoln Lab technology and brought it to the market and created Digital Equipment Corporation and built a company that peaked at about \$14 billion in revenues before eventually selling out to Hewlett Packard.

So you have a long history without institutions. And I mean that there was nothing formal going on at MIT that said, here's a flag that says entrepreneurship. Rather it was embedded in a value system. It was embedded in belief structures. It was embedded in attitudes. Nothing else.

In the '60s, the MIT Alumni Association decided that it would be a nice idea possibly to create a seminar program aimed at alumni who were interested in starting new companies. And I was one of eight people-- I was the only faculty member that was on this committee in 1965 or '6 or '7. And our task was to create the MIT Young Alumni Entrepreneurship Seminar.

We worked on putting together a seminar program that was going to be a weekend. Each of the sessions was going to be run by an MIT alum. Somebody would handle the marketing. Somebody would handle the finance. Somebody would handle something else. And we were going to do this, and we had no idea whether there was going to be interest by alumni in this seminar.

Consequently, we sent out our brochure advertising the program, inviting people to come. I think the charge was maybe \$35, including lunches or what have you. This was big bucks. We told them the dates and MIT. We didn't tell them which room at MIT, because we were nervous about committing ourselves to a size of room, since if we only had a few people show up, it would be very embarrassing if we were in an overly large room.

We sent it, based on my research, to alumni in the classes 5 years to 15 years away from MIT, because that was the hot spot in terms of new company formation, according to my data. When enrollment passed 300, we decided we had discovered something. We cut off enrollment. We eventually had 325 people attend the seminar in Kresge Auditorium. We announced that there would be another session that would duplicate this six months later, and we began planning a nationwide rollout.

The nationwide rollout was the same program, organized in each city across the United States with MIT local alumni. Same pattern. Some local alumnus handling the finance session, some local alumnus handling manufacturing, somebody doing product development. I keynoted every one of those sessions. We did eight sessions over three years across the country, and we had 3,000 MIT alumni attend the Young Alumni Seminar Series of the MIT Alumni Association.

First thing done ever that I've been able to find by any part of the institution that was explicitly attempting to stimulate entrepreneurship and targeting alumni. Okay. Things happened. The MIT Enterprise Forum was the local Cambridge response to the alumni series. We didn't know that it was other than a local thing, so it was called the MIT Enterprise Forum.

And the Enterprise Forum was alumni helping alumni in starting companies in getting off the ground by providing nurturing and counsel and what have you. We didn't realize that we had to later add "of Cambridge," so MIT Alumni and Enterprise Forum of Cambridge became the first one, because now there's 26 of them. And they're all over the world, MIT Enterprise Forums aimed at stimulating entrepreneurship all over the world by MIT alumni, first for MIT alumni. But now the majority of membership in every one of those clubs is non-MIT. So now it's MIT institutionally encouraging entrepreneurship globally via the method of the Enterprise Forum.

Still very little inside MIT. Inside MIT, one course, a replica of the course I told you about that I took at the Harvard Business School. The course at MIT was called New Enterprises, started by an MIT alumnus who returned to MIT after serving in the government as assistant secretary for R&D of the US Army under Eisenhower, finished his role, had sold off a successful company, came to the dean of the Sloan School and said, I'd like to do some free teaching about entrepreneurship and started our first course, New Enterprises. That course still exists, same name, same number that was started way back when.

Okay, still not very much. One course. No student activities. No institutional premises. In 1990, I went to Lester Thurow, who was dean of the Sloan School. And I said, Lester, I want to create an MIT Entrepreneurship Center. And I had a proposal.

Lester said, why do I want to get involved with those kinds of people? And I said, what does that mean? Who are those kinds-- well, you know, it's messy stuff. And it's people who are doing all these kinds of things. I said, wait a minute. Lester, I've read some of your books. And you preach that entrepreneurship is the heartbeat of the American economy and that's the basis that differentiates the United States from the rest of the world.

Lester laughs and says, don't believe everything you read. And I said, well, okay, but I really think this is a good thing. And he says, what do you mean "MIT Entrepreneurship Center"? You're in the Sloan School.

And I said, yeah, but the entrepreneurship is not in the Sloan School. The entrepreneurship is across the whole place. And if we want to capture this field, you've got to be in the majority market, not the minority market. So we've got to create something that crosses all over MIT.

And he says, well, I don't know about this. And he looks at me, he says, who besides you thinks this is a good idea? And I said, oh, hmm, that's a good question. I lean over, grab my proposal off his desk, and I said, I'll be back.

By that time, 1990, I was a very senior full professor. I certainly wasn't scared of dealing with or fighting with deans, and Lester got his tenure one year after I did, so we were good friends for a long time. I came back a month later. I had my appointment, flipped the proposal to him on his desk.

I said, don't bother rereading it. Just turn to the last page. He looks at me, looks at the thing, flips to the last page. It's a signature page, and the signature page is the heads of each functional group in the Sloan School signing off on the proposal to create this. And Lester says, well, okay, so what are we going to do next?

And there we were, so now 1990, first major institution that we are going to start, an MIT Entrepreneurship Center. One course, no student clubs that are meaningful. There's a couple of little clubs that have 20 students each in it, one in Engineering and one in Sloan, but nothing meaningful taking place.

50 years later, 30 courses in entrepreneurship. We had one part-time faculty member in 1990 in entrepreneurship, me-- part time, because I was working on plenty of other things besides entrepreneurship. Today, we have 20 faculty members. Half of them are successful entrepreneurs or venture capitalists, most of them not being paid, appointed as senior lecturers, practitioners who are ecstatic about working with our students and helping them and teaching them and the like.

Half of the 20 are academics from lots of different fields. Some, we've recruited in. Some have transformed themselves. They'd been faculty in other areas and have decided entrepreneurship is an intriguing aspect of their own field of endeavor.

Rick Locke. Rick Locke was a political science guy who focused on international management activities. Rick Locke came to me and said, what you guys are doing in entrepreneurship is neat. How can I get involved? And we started talking about how a full professor with strong background, but not in entrepreneurship, what kinds of things he might do to start to look at the international aspects of entrepreneurship. And he became a very critical contributor. Or alternatively, people like Fiona Murray, whom I hired directly out of her PhD program. She was a one-year assistant professor at Oxford. We brought her in, and she's our guru on the life sciences and entrepreneurship.

Or Antoinette Schoar. Antoinette Schoar was the hottest person in the finance market coming out of University of Chicago. And the head of finance came running into my office. Ed, do you think that you can convince the dean that we could support two sections in entrepreneurial finance? I said, why? He said, the hottest person in the finance market says she will only come here if she can teach the class that she was assistant to at University of Chicago under Steve Kaplan.

This was Antoinette Schoar. And I said, as far as I know, the Harvard Business School has five sections of entrepreneurial finance. We ought to be able to justify two sections. So sure, I'll go in the dean's office with you and fight for this appointment.

So over time, we have built the faculty and their courses. In 1990, the same year we started, we announced the Entrepreneurship Center. We didn't announce it with any flurry. There wasn't any trumpets sounding. We were going to do something, but it wasn't clear.

Three kids show up in my office, and they tell me that they want to start a business plan competition at MIT to get students involved in proposing new business ideas. And they're calling it the 10K Business Plan Competition, because they want to have a first prize of \$10,000. And they're working on getting this thing underway, and they're working on trying to find the money. And they heard that I was now starting up this new entrepreneurship center, and maybe I can help them.

And I grilled them on what it was that they wanted to do, how they were doing it, what they were doing to entice students to come in with business plans. And I said, I'll make a deal with you guys. You focus on building the organization. I'll find you the money.

And they weren't so sure that they trusted me to find the money. They went off, and they started working on bringing people together. They ended up getting 45 plans submitted in the very first year of the \$10K.

I had it easy. I made one telephone call. I called David Morgenthaler, an MIT alum who was running Morgenthaler Capital, a venture capital firm, in Cleveland, not in Route 128 and not in Silicon Valley. In Cleveland. And David was an old friend. David used to come up and talk to me about entrepreneurship since I started my studies in the early '60s. This is now 1990. We knew each other for a long time.

I said, David, and I described to him what the three kids told me. He says, that's really interesting. That's a great thing, something that's very important. Entrepreneurs love entrepreneurs. And they love entrepreneuring, and they love entrepreneurship. That's what they really love.

So David says, hey, that's terrific. So I suppose you're calling me to see if I'll give you the \$10,000. I said, David, I am calling you for that. But I want to warn you in advance. He says, oh? I said, I'm going to call you again next year.

He says, aha! So you're looking for \$20,000. I said, well, frankly, I really would be more comfortable if we had \$30,000, because if I could tell these kids that we've got three years worth of funding for them, they really could focus on planning the build-out of the organization, and it would be great.

He said, so you're looking for \$30,000. I said, David, I'm looking for \$30,000 for them. He said, oh? Well, what else is there? I said, we just started this Entrepreneurship Center. I don't have any research money.

He said, oh, really? He says, and what can I do for you? I said, well, you could do anything for me if you wanted to. But how about \$45,000? He says, so \$75,000? I said, your MIT skills are marvelous. Yeah, \$75,000 would be wonderful. And he said, to whom do I make the check payable?

By the way, since then, David Morgenthaler has endowed a professorship in entrepreneurship, has endowed a research fund in entrepreneurship at MIT and has been one of our loyal supporters for many years. But we started the 10K.

Well, several years later, we had the, unfortunately, widow of an MIT alumni successful entrepreneur come in and say they thought it was time to step up the \$10K. And I said, what do you have in mind? They said, we would like, in honor of my husband, son's father, we'd like to give you \$50,000 a year for the prize for the business plan competition. I said, it's really wonderful of you, but I have a problem. David Morgenthaler's been very loyal and very supportive. I really need to talk to David.

I called David up the next day. I told him what the situation was. He said, Ed, sounds to me like I've been outbid. And suddenly we now had the \$50K. And the \$50K led to the \$100K. And once we got the \$100K, that was a nice number. And the students then decided they didn't want to change the name anymore. We are presently giving away close to \$1 million a year in the \$100K Business Plan Competition. And we have gone from the first 45 in the first year to this year, if I am not mistaken, we had 275 team entrants into this.

Now, go back to first principles. I wanted to create the MIT Entrepreneurship Center. Twenty-five percent of the students involved in the \$100K are from the Engineering School. Twenty-eight percent of the students involved in the \$100K are from the Sloan School. Another 15 percent are involved from other departments and schools at MIT.

Seven percent are from Harvard. Now, how did they sneak in? And by the way, not the Business School. They're from the Business School, and they're from the Medical School, and they're from the College, and they're from the School of Public Health, and they're from the Kennedy School. In order to get in, they have to become part of a team in which at least one MIT person is a principal person in the team.

And then we've got another 15 percent that are not MIT, not Harvard. They could very well be Babson, they could be Northeastern, or they could be industry people who are hanging around, involved, meet some students, and get involved and the like. So we have really, in that organization, created a wonderful activity.

By the way, I think-- and we have data now to demonstrate this-- the \$100K by itself is probably the single largest generator of specific MIT student-based business plans, from the start, of any other activity that is taking place. So if we're getting 275 business plans a year, and we're awarding six first prizes-- one is a bigger first prize than the other, but we're awarding prizes in all these tracks. The \$100K by itself is considerably bigger than the Technology Licensing Office in terms of the initiation of new companies. But the \$100K was merely the manifestation of the first organization that spun out and that got created.

But we now have, in the MIT Entrepreneurship Center, physically, we have the Venture Capital Private Equity Club, the MIT Energy Club, Sustainability at MIT Club, MIT Sloan Entrepreneurs Club, MIT Clean Energy Club. We have all of these clubs, and in our new center, with wonderful idea paint on all the walls so that you can write all your plans, with glass walls throughout so that every student there can see everybody else who are there in their own activities, we have a series of cubicles that house every major student activity at MIT that relates to entrepreneurship.

So we have over the years created a forum that has taken the student activists and given them a place where they come together on a regular basis at all hours of day or night. There is no lock on the door. There are no owned possessions sitting in those cubicles.

Right behind all the cubicles is a large wall of lockers and drawers. Every one of the lockers and drawers has a key and has a sign on it as to whom it belongs to. The students are, on average, 5 to 10 feet from all their possessions, which can be moved into their cubicle whenever they're coming together for a meeting. And for the most part, nobody erases anybody else's work on their walls.

So what we've done, in part, we have really motivated, assembled, nurtured, instructed, the students. To me, the key heartland has been what's happened since 1990, not what happened-- what happened since 1967 in the outside world, was to begin to create an external community in which MIT alumni were encouraged. The Enterprise Forum helped them out, created linkages into MIT.

By the way, the first three years of the 10K, the finals were held at an annual meeting of the MIT Enterprise Forum, because the Enterprise Forum was the only MIT-associated organization that could pull together a large enough audience to be an audience for listening to a series of students presenting business plans. Now the \$100K performs on its own in Kresge Auditorium to an overflow crowd of hundreds and hundreds of people who are there to encourage their buddies, their friends, their classmates, and the like.

So that's taken 20 years of growth and development of clubs and of courses. They've gone together, the clubs and the courses. It has not been 20 years since we had a physical space. It's been maybe 12 years that we were first given a physical space. Until then, we were a virtual organization. My office and a secretary was the organization.

And then we got some space, we hired Ken Morse to come in as managing director. Now we've hired Bill Aulet as managing director to succeed Ken. We now are no longer the MIT Entrepreneurship Center. For the past two months, we have become the Martin Trust Center for MIT Entrepreneurship.

Same physical location, 50 percent larger, totally redone, and it's beautiful and wonderful. It's great. But Marty Trust, who is a Sloan School alum and very successful entrepreneur, contributed a significant amount of money to the Sloan School toward our great new building and toward endowing a much larger piece of the entrepreneurship center. So we have, for two months, changed our name, and so we are now the Martin Trust Center for MIT Entrepreneurship.

So I think those have been very critical, and in my biased opinion, the most important things. Now, what else has happened in creating the ecosystem? Ten years ago, in the year 2000, MIT, as MIT central, created the first institutional organization that you would say is part of this ecosystem, other than the Entrepreneurship Center, which had been created 10 years before.

And 10 years ago, in the year 2000, we created the Venture Mentoring Service. The Venture Mentoring Service was created explicitly by the encouragement of the then provost, Bob Brown. Bob Brown is now president of Boston University. Bob Brown talked to a prospective donor who wanted to give some money to help nurture MIT-based entrepreneurship. And they talked a lot about it.

And the Entrepreneurship Center was involved in drafting the first drafts of what this organization could be. In the end, two major donors came in with, I believe, \$2 million. The provost gave them space right under the Dome in Building 10, and the Venture Mentoring Service was established.

And it was established to assist any MIT undergraduate, graduate student, alumnus, staff member, faculty member, who has an idea for starting a new business. And the way they work is very straightforward. They have over the years assembled a wonderful group of mentors. Most, but not all, of the mentors are MIT alumni. They have now about 120 mentors.

You, as someone with an idea, walk into the VMS-- the Venture Mentoring Service-- without an appointment. And you get treated as you would be treated if you walked into an emergency room of a hospital. The first person who talks to you is like a triage nurse in an emergency room. The job of the triage nurse is to figure out what kind of help do you need so that that person can route you to the right help for your need in the hospital?

Same role in the Venture Mentoring Service. You come in, you get interviewed. You fill out a form discussing what it is you're interested in doing. And that person discusses with you what you're really trying to do, what kind of person could best help you. And now, knowing the 120 mentors that they have, they will assign not one anymore-- they started assigning one-- now they assign two mentors to anybody coming in asking for help.

Why two? Because one, two is better than one. Secondly, two is at least twice as many ideas as one. But more importantly, two is a very different probability that one of them will work out well with you in terms of relationships. And they've learned that, so they've shifted their model. The Venture Mentoring Service has become an enormous aid to stimulating and helping the nurturing of someone who has an idea. And they've got a track record.

Two years later, the next important institutional thing took place, which is a piece of the ecosystem. Alex d'Arbeloff, a great MIT entrepreneur, founder and CEO of Teradyne, built it up to a couple of billion in revenues, Alex had retired under his own rules of forced retirement as CEO of Teradyne and was the chairman of the board of MIT. Alex encountered this Indian immigrant who had gone to Canada to try to be an entrepreneur and didn't like the Canadian environment for entrepreneurship so moved to Boston, a guy named Desh Deshpande. And Desh Deshpande, in Boston, became a very successful two-time entrepreneur and made a lot of money in the two companies that he founded here.

And Alex d'Arbeloff got to know Desh Deshpande, a person with no connection to and no attachment to MIT. And Alex and Desh came up with the concept that they could create at MIT a research center that would fund MIT faculty research ideas that, in particular, had high probability of being commercialized as the basis of a new company.

And Desh gave \$20 million to MIT to establish the Deshpande Center, which runs on that basis. It solicits annually research proposals from MIT faculty. Its initial grant is \$50,000. The later grant, if they still make progress, they can get up to \$200,000 as a second grant. They are grants from Deshpande funding for this.

The twist is that it isn't just a situation where senior MIT faculty are judging research proposals by other MIT faculty. The judging group certainly contains senior MIT faculty. But it also contains successful entrepreneurs and successful venture capitalists. So suddenly, the criteria for giving somebody that \$50,000 first grant is not only, is this an intriguing research idea by an MIT faculty member, but it's one that we think has the kinds of legs that it could become the basis for a new company when the research is much further along. And the Deshpande Center has become a great instrument.

Now, the Deshpande Center, when announced, heavily because of Alex d'Arbeloff-- Alex co-taught with me in the Sloan School Entrepreneurship and Innovation-- the announcement of the Deshpande Center said, the Deshpande Center will cooperate with the MIT Entrepreneurship Center in bringing students to bear on the research proposals funded in Deshpande to try to develop them into commercialization plans for movement out as new companies. And two years after Deshpande was set up in 2004, when we now had stuff a little further along, we created what we call the Innovation Teams course. The Innovation Teams course is a course of the Entrepreneurship Center, taught with the Deshpande Center.

The feeding content are the research projects coming through the Deshpande Center and getting ready to the point that they're ready to be evaluated, assessed, and helped. The student teams are mixed teams, Sloan School, Engineering, and Science teams. The teams are formed on day one-- or actually, before day one. They have to apply to the professor in charge of the course.

For most of the time, Fiona Murray has been running this. Now, this semester, Fiona's on academic leave. She's on sabbatical. Noubar Afeyan, one of our successful practitioner entrepreneurs and senior lectures, Noubar is running Innovation Teams. So the teams, essentially, they don't really bid on them, but they indicate what their priorities, which group they'd like to be on, and every team is a mixed team, management and technology together.

Each team takes one project the whole semester, develop a commercialization plan for that project. The commercialization plan may, at the end of the semester, say, we don't really think that this is a great idea for a company. We think that the project should end where it is. Or, we think this is an interesting idea, and we think it's much too soon, and it ought to be carrying out another year's worth of research before it's ready to really have big time. Or, we think this is a terrific idea for a large company to take on and add to its present product line.

Or, we think this is a great idea that has the potential to be a startup new firm. And here is the first draft of the business that we propose for doing this. And you have a flow from innovation teams, or we call it I-Teams, into the \$100K competition as one of the steady routes. And the Deshpande Center, particularly along with the I-Teams course, has become a major piece of the institutional fabric of what's going on.

The final institution thus far-- and there's more in the works. But the final institution thus far was five years ago. Five years ago, Dick Schmalensee was starting what he knew was going to be his last year as dean. He'd been dean for eight years of the Sloan School. He was in the final throes of attempted fundraising, which he finally succeeded at during that year, for our wonderful new building. He raised \$160 million for launching this new building.

He wanted to have something to his credit besides the building, which some people might think, by itself, was enough. He started a series of faculty retreats at Sloan to come up with new ideas for educational innovation. What came out of three faculty retreats was strong support for launching an intensive track in the MBA program called the Entrepreneurship and Innovation track. A year later, we launched a second track in Finance. This year, we're going to launch a third track in global management.

But the track in entrepreneurship was the first track started five years ago. I became the director of the track. This year, 50 percent of the incoming MBA students at Sloan-- 180 out of 360 incoming-- applied to get into the Entrepreneurship and Innovation track. Fortunately, we were able to limit the number, because the largest classroom in the Sloan School holds 120 students, not 180 students.

So in five years, we have grown intensity of focus within the management school enormously. And if I did nothing else whatsoever except cater to the needs of the MBA students that are coming through the E&I track, I would have plenty to do, because in a way, I run my own venture mentoring service, because they're in and out of my office all the time with ideas. And they have ideas galore.

A very substantial fraction of them have already been entrepreneurs. They have started a company. It may have closed down. It may have been sold off. It may still be going. And they're now coming to business school because they want to up their own ante to a higher level of professionalism and knowledge. They want to access more advanced technology to build a next company.

They want to find a different set of business partners and co-founders to get a company off the ground. They want some formal learning to add to what, in many cases, was their technical background and their own personal experience. Their motives are widely ranging, but boy, they're passionate about wanting to start companies. And that's been the third, within the last decade, institutional change.

So all of those have become very important bricks and mortar of an MIT ecosystem. There's a lot of underlying stuff that's been around. Most importantly, the attitudes, the policies, the kind of people who are attracted to come here from the very beginning, because it was such a different kind of place, that probably is the most important thing. That's the hardest to document. The institutions are easier to document, and we can show the tracks coming out of each of those institutions and what's taken place.

Now, let me just add three things that are going on right now.

**INTERVIEWER:** I know you have a meeting to go to.

**ROBERTS:** Right now. Number one, last year, Susan Hockfield, as president, decided that MIT needed to submit a white paper on innovation to the White House in which MIT pulled together its recommendations to the White House as to what should be done to stimulate entrepreneur-- not entrepreneurship, innovation. It turns out that the white paper heavily went into entrepreneurship.

Susan held two major closed seminars of invited faculty to come around and doing things. Coming out of the seminars was not just the white paper but a decision on her part that we ought to try out a pilot seminar series for faculty of MIT on commercialization and entrepreneurship. Last year, Fiona Murray and I, reporting to Claude Canizares, who is the associate provost and VP of research at MIT, ran an eight-session seminar series aimed at helping the MIT faculty to learn more about commercializing and entrepreneuring their own ideas.

The primary exemplars in every one of the sessions were experienced and successful MIT faculty. But we had them organized explicitly by key topic, and we were adding to them, and the like. So that was done last year. I'm sure there'll be more of that to follow.

Second, we have just completed the first draft of a proposed undergraduate minor in entrepreneurship for all of MIT. This is not a major. This is a minor. Undergraduate. So we are hoping-- and this is a proposal to the dean of engineering and to the dean of Sloan-- we are hoping they will agree to co-sponsor and move forward with a minor program that will allow anybody in any department at MIT at the undergraduate level to take a cluster of courses that will have experience in doing entrepreneurial kinds of things, as well as lessons involved, as well as classroom stuff, and that's under discussion.

And the third thing that may, in fact, turn out to be the most important thing, is that the dean of engineering and the dean of Sloan have together appointed what they call the Ad Hoc Committee on Innovation and Entrepreneurship. The Ad Hoc Committee is a very senior faculty committee to look across all of MIT, and by April of this year-- so we've got another four months or three months to work-- come up with recommendations for what should MIT be doing across the board to further stimulate entrepreneurship and innovation at MIT at all levels? And I don't know what we will be coming up with. But when I leave you, I go to this week's meeting of that committee to help see if we can further these ideas.

**INTERVIEWER:** And I know you have to go to that meeting right now. So Ed, I just want to say thank you so much for sharing your time with us, and the journey continues. This is a wonderful place to end, I think.

**ROBERTS:** Chris, I want to thank you for giving me the opportunity of having someone record the history, the ideas, the thoughts, and, frankly, my own passion for what we have accomplished over all of these years and what I think there is still to accomplish at MIT.