INTERVIEW
WITH
JOHN STERMAN
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Sloan Oral History Series

J: John Sterman
B: Bob McKersie
G: George Roth

G: What we would like you to do is just tell us your story. We should talk very little, other than to ask you questions that help deepen your story.

B: We start with when you came to MIT and what prompted you to come here in the early days?

J: I did my PhD here, so I arrived here to start that program in the fall of 1977.

G: You came from Dartmouth?

J: Right. I had done my undergraduate at Dartmouth. I graduated in 1977, so I came straight from that to the doctoral program.

But I should go back even farther. I first learned about system dynamics when I was a junior in high school. That must have been 1971. My father, who was a research chemist, brought home one of Jay Forrester's articles for me to read. It was a very famous article called, "Counterintuitive Behavior of Social Systems." It was new at that time, and had just come out. As a nerdy kid, I'd been reading a lot of science fiction, and what was then called future studies or futurology. For example, books by Alvin Toffler, Herman Kahn etc. I was unhappy with most of that stuff because it seemed like a lot of blather and there was no way to test any of it. It also required an awful lot of words to push the author's positions.

Forrester's article is short, it's clear, and it remains a classic to this day. You can read it today and it's just as fresh in 2013. The most amazing thing about that article from my point of view—besides the fact that there was a formal, systematic simulation model in there—was his early world model. He said, "It's a model. Models are wrong. This model is incomplete and preliminary, and there are a lot of things wrong with it. All the equations are available, take a

look at this book," which was *World Dynamics*. "All the equations are in there and you're welcome to modify it and improve it." I thought that was incredibly refreshing. He had this completely undefensive attitude, and there were these insights that were really profound. As a 17 year old, what did I know? It really made a big impression on me.

I ended up going to Dartmouth College for my undergraduate degree. The decision rule for that was "where could I go that would be a good school where I could ski?" I never applied to MIT or Harvard or Yale or any of those places. I had no interest. I wanted to go where I could ski.

G: You had a decision rule which made it easy?

J: Yes. I spent a good chunk of the fall semester of my first year not going to football games or frat parties, which is not to say I never went to any, but I spent time in the computer center working on the mainframe programming Jay's World Dynamics model. He had invited people to improve on his model, so I translated the model into Basic, the computer language that John Kemeny had invented. He was the President at Dartmouth and every student had a free account on the college mainframe.

G: You had access to a computer in high school?

J: I did, but it was one time-sharing terminal to an IBM mainframe at the IBM Yorktown labs. The very first computer language I learned was called APL, which is a very interesting story. It stands for "A Programming Language." Developed by a guy named Ken Iverson, who was an unusual person, kind of a quirky genius. A computer program that might take three pages of code in an ordinary language might be six lines of APL. It was compact, elegant and beautiful—and completely impossible for anybody to understand.

In the fall of my freshman year in college, I'm programming Jay's *World Dynamics* model in Basic, and I got it running. One of my friends came by one day and said, "You know this weird stuff you've been working on? There's something just like it in the public computer library of the Dartmouth mainframe."

I said, "What?" I immediately checked it out, and it was the World3 Model, the Limits to Growth Model, that Dana and Dennis Meadows had done. I had no idea there was anybody doing system dynamics at Dartmouth. They had just moved to Dartmouth from MIT and joined the faculty. I went to their offices, introduced myself, and told them what I was up to.

They said, "We're going to teach a system dynamics class this spring, why don't you take it?"

I did. That was the first system dynamics class that they taught at Dartmouth. I was planning to be a physics major, but I changed from that to a special major that I had to create, which was basically a system dynamics major. It was systems dynamics classes, other modeling methodology classes from OR, some economics, and some environmental studies. Along the way, I kept going with physics and chemistry.

G: Was this spring of your first year?

J: My freshman year, yes. 1973-74. I took all the system dynamics and related classes that they offered. I did a lot of skiing, and I would spend weekends driving down from Hanover to Plainfield, New Hampshire, where Dana and Dennis lived on a farm they were restoring. I worked most every weekend on the farm. When they first moved in there, the farmhouse was in rough shape. They did a major renovation, which I wasn't involved in.

The land was also in rough shape. The main pasture had been allowed to overgrow for 20 years or more, and there were some large trees in it. Dana wanted sheep, so the first order of business was to clear the pasture. On Saturdays, I and a couple of other students would drive down, get out chainsaws, and clear the pasture. I don't know how big it was, maybe 20 acres. We built a fence around it. It was a lot of work, took a while, and it was a lot of fun. We stayed for lunch, dinner, and had these amazing conversations about system dynamics and what we would now call *sustainability*.

I did a senior thesis applying system dynamics to world population, economic growth and environmental issues. I was a philosophy minor and in my senior year I did a foreign studies semester at the University of Edinburgh.

G: There's no skiing there!

J: There's good hiking in the Scottish Highlands, and we did some of that. That was the fall, and in the winter, Dana and Dennis invited me to join them on sabbatical at IIASA in Laxenburg, outside Vienna (the International Institute for Applied Systems Analysis). The Cold War was still on; IIASA had been established around 1973 as part of détente. Nixon and Brezhnev signed the agreement that established it.

B: Howard Raiffa had a relationship.

J: Howard Raiffa was the Director, I think he was the first director. It was an interdisciplinary systems analysis institute in a neutral country, Austria. It brought together scientists from East and West working on global issues. I spent the winter quarter there, working on what became my senior thesis. I was mostly just learning and going to as many talks as I could.

That's where I first met Amory Lovins. He was largely unknown at that time, but Dana had invited him to come to IIASA. He had just published his famous article called, "Soft Energy Paths" in *Foreign Affairs*. He was converting it into a book-length treatment, which became a defining work called *Soft Energy Paths*. I also had an opportunity to travel to Romania, Hungary, and a variety of other places. It was a fantastic experience.

It was very clear to me, even before I did that year abroad, that I wanted to go to MIT for a doctorate to study system dynamics. I applied while I was in Scotland. And Dana and Dennis were working very closely with Jay.

I had never been to MIT for any reason, ever. I had never met Jay. I had heard a lot of stories about Jay from Dana and Dennis though. One day I was sitting in my cubicle at IIASA, working away. There was no internet, no cellphones. An international overseas phone call was a big deal. Somebody came to tell me that I had a phone call from America. I went and picked up the phone and it's Jay. He said, "This is Jay Forrester at MIT." I said, "Hello!" He said he was calling to let me know that I had been accepted into the doctoral program. As I learned later, in characteristic Jay-fashion, he said, "We're offering you a fellowship. It's very

competitive and funds are limited, so I need to know right now if you plan to accept this offer. If you don't, we will offer those funds to another deserving candidate."

He demanded that I give an answer right then and there. I said, "I can't do that right now. I need to think about it." I was also accepted at Stanford in their engineering systems program and they had also given me a financial offer.

"I'm coming back to the States in two weeks and I'd love to come and visit MIT."

Now, I had NO intention of going to Stanford! I knew exactly what I wanted to do, but I didn't want to agree to what Jay wanted me to do right off the bat. After I got back to the States, I drove up here for the first time. I have to tell you, driving on Memorial Drive for the very first time and seeing the Great Court and the names of all the great scientists carved into the limestone made a big impression on me.

I met with Jay and other people from the System Dynamics Group. Met everybody, talked about what the PhD program was like, and what I wanted to do. And of course I told them I was going to come.

G: That's a characteristic story of how the place worked.

B: And how deep your roots were in system dynamics.

J: Yes, absolutely. There was no question that's what I wanted to do. As I was finishing the PhD program, I did not think I was going to stay on the faculty here. I knew I wanted to be a faculty member, but I thought I was going to go back to Dartmouth so I could ski and be in the woods more – and Dennis had arranged for an offer. I pretty much had a job offer at the System Dynamics Group that they had created there.

B: What year are we now?

J: I finished my doctorate in December 1981. You all remember Sharon Cayley? Sharon was the administrator of the doctoral program at MIT for 35 years. She just retired this

past spring. She was new to the job the year I finished. Back then—and still today, I think—you have to turn your thesis in on archival paper, not just electronically. Back then, there was no electronic submission, and she gave me a little paper receipt acknowledging that.

G: The library gives you that, right?

J: She did it, and her signature is on it. That was in December of 1981.

I thought I was going back to Dartmouth – and there's another interesting Jay story here. During the winter of 1980-81, he asked me to join him for lunch at the Faculty Club, which was in the old Sloan building at that time. I didn't know the agenda. I had lunch with him quite often because I had worked with him on my PhD thesis and as an RA on his National Model. We sit down for lunch, and he starts asking me, "Well, what are you plans after you complete your degree?"

I said, "I'm pretty sure I'm going to go up to Dartmouth and join the System Dynamics Group there." He said, "Well, I think you ought to consider joining the Sloan School faculty."

I said, "Tell me more." And we talked about it for a while. At the end of the lunch, from my memory, I said I would think about it. Part of the reason I was serious about thinking about it was at that time I was dating Cindy, who later became my wife. She was here in Boston, so my interest in going to Hanover was fading. I didn't hear anything more from Jay about this. The next thing I know, April maybe, I get a letter from Abe Siegel, the Sloan Dean, saying, "Congratulations on your appointment to the faculty. [laughing] You start July 1."

G: While you were working on your dissertation?

J: I was still a doctoral student. I never told Jay, "Yes, I will accept this." Or, "I would like to have a position." Jay couldn't make an offer to me, and I never said "yes I'd like to do that." There was no job talk, no search committee, nothing. I get this letter from Abe saying, "Congratulations. You've been appointed to the faculty at a salary of…" I don't even remember,

but I think it was $33,000/year or something like that, with no summer support, and you start July 1. I wasn't done yet; I had not defended my dissertation.

My personal situation had evolved. I did not want to leave Boston, so I accepted the offer. I wasn't done with my degree, and my first semester as faculty, the fall of 1981, I taught my first introductory system dynamics class as a faculty member. I'd been teaching before that, while I was a doctoral student.

When I was a doctoral student I taught for two or three years at Northeastern in their night program. I taught system dynamics. It was a great experience. I got terrific teaching experience, and although the students there weren't perhaps as technically capable or had the math aptitude of MIT students, they really wanted to learn. They go to night school after working full-time. It was very impressive to see that commitment. I'm still in touch with one of those students, who became a professional modeler. He'd been in the nuclear Navy, and we're in touch 36 years later.

B: Backing up a minute. Who else was on your committee?

J: My dissertation committee was Jay and Nathaniel Mass, who had been one of Jay's doctoral students, and joined the faculty in the mid-1970s.

And Roger Naill, who had been a Sloan masters student. He got his PhD under Dennis at Dartmouth and went to work for DOE when it was first created under the Carter administration. They had an Office of Policy Analysis that needed models to do analytic support for energy policy. Roger was tapped to run that and hired me as a summer intern. After working for the summer I took a leave of absence for the fall semester because they asked me to stay on. I spent six months at DOE where I worked on system dynamics energy models.

One of them was called the Fossil2 model, which was an elaboration and development of Roger's PhD thesis, which grew out of his Sloan master's thesis. The other one was the first world oil market model DOE ever had. They called that the WOIL Model for World Oil.

There are quite a lot of MIT-Sloan connections here. The Secretary of Energy in that era was Jim Schlesinger, who had been head of DOD before that. At some point in his career he had also run the CIA. He was a very, very smart guy, in the McNamara mold. Super smart, technocratic, and knew the Washington inside game. He was the first Secretary of Energy.

People don't know this but Jimmy Carter, Democrat, was the President who deregulated the oil and gas industries in the US. Oil and gas had been regulated, and prices were set. After the first oil shock in 1973, Carter came in in 1976, was inaugurated in 1977, and then put forward the legislation to deregulate.

We developed the system dynamics models that became analytic support for DOE's assessment of the different versions of the legislation as it moved through the Congress. Schlesinger would go up to Capitol Hill to testify about what the impact, the benefits, and so forth would be. It was a very interesting education in how the sausage factory works. I naively thought that the right way to do policy analysis was to do the analysis as honest scientists, and share the results with the chain of command. It would get to Schlesinger, and he would use that analysis as the basis for his testimony. Sometimes that's what happened, but more often, as the bill would be amended, he would go back up and testify. This was usually for John Dingle's subcommittee. Dingle was very powerful even way back then; he ran the House subcommittee on Energy and Power.

Dingle's chief of staff was a Sloan alum who had done system dynamics working for Jay. He was Chip Schroeder, or Walter W. Schroeder III, I believe was his full name. Chip had gone to DC and become Dingle's main aide. Chip knew a lot about system dynamics models. Anyway, there are two stories here.

Schlesinger would go up to the Hill, and the bill had been amended since his last appearance. He would be asked, "How many trillion cubic feet of natural gas would be the incremental supply if this version of the bill were to be enacted?" He would make up a number. I mean, he was well briefed, so he knew the ranges, but he would just state a number and a price to go with that. The word would filter down to us, "You'd better make the model do that."

G: Under what conditions would he have been right?

J: He would make up a number and come up with the backing for it. This is, of course, absolutely wrong, unethical, the wrong way to do modeling. As the most junior of the most junior peons, there was nothing I could do but watch with wide eyes how the process actually worked. It was a terrific education in the real world. I don't know that it's all that different today.

One day Roger came in to the bullpen—we all worked in an open area—and said, "Listen. We just got a request through the chain from the White House. They're trying to round up enough votes to pass this bill, the national energy plan, and Senator X from such and such a state wants to know what the impact would be on his state." I forget what the exact issue was, perhaps how many barrels of oil per day would be consumed in his state under the bill. None of the models that DOE had could answer that question. They weren't disaggregated to the state level. Even if they were, the data weren't available. The request came in and they said, "We have to know by the close of business today."

I always ask the students when I tell this story, "So what do you think we did?" I'll cold call you, George.

G: I would look at the history and made some kind of projection.

B: You followed Jim Schlesinger's model.

J: We got out an atlas, at that time of course there was no internet, no web, it was a paperback book, the *Statistical Abstract of the US*. We looked up the population of Senator X's state, and we divided that by the population of the US, and scaled the number that came out of the national level model. That was the best you could do.

G: There was a basis for it.

J: We had a procedure. It wasn't a very good estimate but it was better than nothing! There's also an interesting story about Chip Schroeder, too. He had been a Sloan Masters student, and he had worked extensively with Jay and the others on the Urban Dynamics model. I

didn't know him when he was a student; he graduated in 1972 or '73. I had met him at some system dynamics social event, but I didn't know him, and we didn't overlap as students. He had done a really interesting system dynamics Master's thesis adapting Jay's Urban Dynamics model to the City of Lowell. Lowell was extremely depressed after the textile industry went to the South and then to Asia. Lowell had been an incredibly vibrant place during the early Industrial Revolution, one of the huge engines of prosperity for New England. It was very famous in the labor movement, for the Bread and Roses strike.

B: That's Lawrence, actually.

J: That's Lawrence, but Lowell and Lawrence are right next to each other on the Merrimack River. Lawrence is just a little downstream. An interesting place that had fallen on hard times. It had all the urban ills – abandoned buildings, decrepit tenement housing, massive quantity of unused, abandoned mill space, crime and drugs, all of it.

Chip adapted Jay's Urban Dynamics model, which was a general model of a typical city, and calibrated it to the data for Lowell. He worked with the Lowell city leaders. The mayor wanted to know what could be done to revitalize Lowell. The model showed that the best thing that could be done would be to attract sources of employment, and make room for that by using a lot of the old mill space – but also tearing down some of the decrepit housing. That part of the policy, which came out of *Urban Dynamics,* was controversial because most urban planning people during the era of the Great Society, going back all the way to the 1940s, that it was best to build subsidized, low-cost housing. Of course, such housing, like Cabrini Green and similar places, became traps from which people couldn't escape poverty. Jay's model said, "No. You shouldn't do that. Tear down some of that and use that space for businesses that create jobs. People will come, and they will need housing. Housing prices will rise enough to make it attractive for developers to build it. If jobs are scarce, wages will be good, people will be able to afford that housing, and it will be an engine of upward mobility."

After the model was calibrated to Lowell, that was basically the result. The mayor—and this is second-hand to me so it requires confirmation—turned down an offer for

substantial money from HUD to build subsidized low-cost housing and instead figured out how to direct the money toward attracting businesses. They worked to create what's now the national park, which attracts a lot of tourists. It's a fantastic place. They eventually attracted the world headquarters of Wang Computers, which was built at the crossroads of Rt. 3 and Rt. 495 in Lowell. That building is still there today.

Chip had done all this, and then he went off to Washington. Dingle's committee had to give thumbs up or thumbs down on all the energy policies Carter wanted to put through. We were asked one day to take our world oil market model to Capitol Hill and show it to them. At that time, a computer was a mainframe and we accessed it through an acoustic coupler modem. It was a very happy day in our office when it was upgraded from 100 baud to 300 baud. Chip had a time-sharing terminal in their offices on Capitol Hill. We go over there with the model. I'd been carefully taught by Dennis and Dana, and by Jay, and all the courses that I'd had in system dynamics up to that point here, with Jim Lyneis, Nat Mass and Gil Low and all the other people who were on the faculty then in system dynamics. They always urged:

"Make sure your models are robust under extreme conditions. Don't just make sure it fits the data. The data only cover a narrow range of experience. You're building a model that's designed to assess policies that are specifically aimed at moving the system out of where it's been into some new regime. It needs to be globally robust."

Chip had had the same training. We go up there, and we access the model. You have to remember that there wasn't a screen, but a teletype printer that would print out model results one line at a time on paper. The first thing he said after we showed him the base case is, "OK, let me try something."

He said, "All right. I'm going to do an extreme conditions test. What we're going to do is take all the OPEC production out of the market, so it's another oil embargo. But unlike the first one, it's a 100% embargo and it sticks."

We had not done that before. I always ask my students when I talk about the importance of building robust models, "What do you think should happen?" Well, the price of oil should shoot way up, right? What should happen to oil demand? It should fall, but it can't fall to zero. And the cost of all that oil is going to slow down economic growth because the price will be very high. Then what's going to happen? Well, this very high price of oil is going to induce a

lot of exploration activity everywhere else in the world, but that takes time. After a long lag, say 3 to 5 years, new production will enter the market, the price will peak and eventually come down, and because of the long time delays, it's going to undershoot where it was before. You'll have a long period of very low oil prices.

He did that test and that's what happened. And nothing crazy happened in the model. Nothing went negative that can't go negative in your life. Chip was pretty pleased. That exercise gave him a lot of confidence that our model was something that could be legitimately used.

There were two things about this that were important. One was the extreme conditions test, and the second was that it was interactive and he did the test.

G: He gave you the parameters to put in.

J: He did it! He knew how to do it. Had he been somebody who didn't know system dynamics, it would have been the same story. We would have typed it in, but he was in charge of the experiment. He was in charge of the learning. That, of course, turned out to be a major theme in system dynamics going forward.

Chip's experiment happened in real life in 1979 with the Iranian Revolution. Iran's production was removed from the world market, and the price of oil spiked up dramatically. As a result, there was a recession and a drop in oil demand around the world, including in the US. Then came a huge surge in exploration—in Mexico, the North Sea, and all over. Three or four years later, the price of oil started to crash, and it crashed well below what it had been before, then stayed low until the late 1990s. The model turned out to be rather accurate.

I went back a few years ago and looked at my lab notebook from that time with all the runs of the model, and it's amazing how close it came to what happened in that scenario. Obviously, we couldn't predict the revolution in Iran. But given that shock, the model came quite close in assessing the consequences. That was a very important piece of my education.

G: And all this was in that six-month window?

J: Yes, absolutely. Then they were asked in Roger's office, "Can you assess the impact of volatile oil prices, embargoes, and things like this, on the economy?" DOE didn't have a model that could do that. We had energy models that took economic growth, interest rates, inflation rates, cost of capital as exogenous, but after the first oil shock there was a big recession. After the second oil shock, there was a big recession. People wanted to know what happens when the price of oil goes up, to economic growth, to inflation, interest rates, unemployment, etc.

We had no macro-economic model for that, so that became my dissertation topic. Roger funded it. I received a grant from Roger after returning to MIT, although technically I couldn't be the PI because I was still a grad student. Jay or Nat Mass was the PI. It was money that I raised in my project. Jay wanted me to work on the national model, which was a major macro-economic model he had been developing since before I joined the group. I worked on that as an RA. But the pace was slow, and the way Jay wanted energy integrated into the model was different than what I wanted to do, and different than what DOE needed. I ended up building my own national macro-economic model, and that became my dissertation.

B: This is fascinating.

J: This is still before 1981!

B: All these connections. I'm sure people have used the term, "the systems dynamics diaspora" in terms of the way people are positioned and connect. It's amazing.

J: System dynamics was a small deal up until Ed Roberts. He was the first doctoral student Jay ever had. Ed was around and still active in system dynamics at that time, and I took classes from Ed. There just weren't that many people in the field for many years.

G: Well, it was founded just a short time before you…

J: It was 1956 is when Jay came to the Sloan School. His first system dynamics article was published in HBR in 1958. His book, *Industrial Dynamics* was 1961. I think Ed's

degree was 1963 or ’64. Dennis [Meadows] got his PhD in 1969 or ’70. It was a very, very small community for many, many years. For a long time, until probably the end of the 1980s, it was possible, and in my case it was true, that you could read everything in the field of system dynamics and have met everybody who was active in the field.

That has long since ceased to be true. It was both a blessing and a curse. You really got to learn deeply from these people, but it was a small field. Very few trails had been blazed.

B: All right. We should probably go now to when you receive the letter from Abe Siegel and you started your career here.

J: I’m not done with my dissertation, and I’m appointed to the faculty. I accepted that appointment, and I started teaching. I taught my first class as a professor here in the fall of 1981. I was working to complete my dissertation. It was not a fun semester, and I always advised doctoral students ever since then never to do that. Finish the dissertation and then start teaching.

I started out teaching a mix of undergrads and grad students. I made all the rookie teaching errors that it’s possible to make and then some. I developed my energy research and tried to build up the group. A lot of people left the System Dynamics Group. Either they didn’t get tenure or in one case, Gil Low was killed in a car accident. There was a fair amount of attrition. By the late 1980s, I was the only faculty left. We were still training doctoral students and other system dynamicists.

B: Jay had retired?

J: Jay didn’t retire officially until 1989. But the other junior faculty, it was clear that none of them were going to get tenure. Of course, they went off and had great careers at other institutions, but they weren’t going to get tenure here at the Sloan School.

G: Who were those?

J: Nat Mass; Gil, who was killed; John Morecroft, who went to London Business School and has done very well there; Jim Lyneis, who became managing director at Pugh Roberts Associates. There may be a couple of others.

G: Where was Ed Roberts?

J: Ed was a full professor. He was the David Sarnoff Professor, as he still is. By the end of the 1980s, Ed had moved out of system dynamics and was focusing on his entrepreneurship work. I feel fortunate that I was able to study system dynamics and learn from Ed when I was a doctoral student, and to have his counsel as a junior faculty member. He was quite helpful.

It was a pretty uncomfortable position to be in, as the only surviving junior faculty member. Back in those days, because of *World Dynamics* and *Limits to Growth*, which were very controversial, particularly among academic economists, I would say there was hostility toward system dynamics among some of the Sloan faculty.

G: Here probably more so than anywhere else?

J: Right. Whether this is because of Jay's personality or not, I don't know.

G: I do remember the quote from Jay, "Why don't you cite other people's work?"

J: My recollection of that—and I've heard him say this many times—is that academics would criticize Jay because there weren't very many references to prior literature in his books, for example, Jays' *Urban Dynamics* had few references to the literature in urban planning and urban economics. This wasn't just about *Urban Dynamics*. You look at *Industrial Dynamics*, his classic textbook, there are practically no references in it. When he was asked about this, his answer was, "I believe a reference is exactly that. You're referring a work to the

reader. You're truly suggesting that the reader should go and read it." Jay was never somebody who was going to put references into a paper just to show obeisance to other people in the field.

There's a long standing tradition in academia of log-rolling. "I'll cite your papers, you cite my papers." Junior faculty cite this huge array of other people's papers because they don't want a potential journal article referee to ding them for not citing what they consider to be the most important work in the field, which of course is theirs. Jay just never bought into that. He just wasn't going to do it. Period. You've got to respect that.

Meanwhile, there was this serious degree of animosity. I'd been working on the national model, working on energy policy, and macro-economic issues in my research. When I was up for promotion to untenured Associate, I was promoted. But the feedback came back from Jake Jacoby the head of the committee, a really great guy. He had done a lot of modeling and wasn't a doctrinaire economist. Later on he and I worked together supervising lots of students. We've worked together on climate policy. He's terrific.

He sat me down after the AWOT promotion review and said, "Listen. If you keep doing this macro-economic work, there's no way you're ever going to get tenure." Tenure was a couple years away. That was a little discouraging. Meanwhile, other people were telling me, "If you don't get tenure in system dynamics at MIT, it's going to die out," which was certainly true. That was a lot of pressure.

At one point – I think Glen might have been Dean at that time – the School reorganized into areas. Sloan was reorganized into BPS (Behavioral and Policy Sciences), EF&A (Economics, Finance and Accounting) and Management Science. At that time system dynamics was in BPS, and John Little was the first area head for BPS. Some BPS faculty thought was a vote of no-confidence in them because John, who is a fantastic guy, was in Marketing and Operations Research, both part of Management Science. He wasn't a BPS faculty member. BPS people were really annoyed. But I think John did a great job.

At one point the Dean asked John Little to chair an ad hoc committee on the future of system dynamics at Sloan. This was probably 1987-88.

B: That would probably still be Abe Siegel.

J: I believe Lester Thurow was Dean. What was this committee about? Everybody in the system dynamics group and in the community worldwide knew that this committee was basically the Sloan School trying to decide whether they wanted to have system dynamics around here.

The conclusion of the committee, as I recall it, was, "Here are the pros, and here are some issues. Sterman is the only junior faculty member. He's going to be up for tenure in a year or so. Why don't we wait and see whether he gets tenure?"

G: More pressure.

J: This problem solves itself, right? More pressure. I did get tenure, and I remember very clearly getting the phone call from Lester with that news. It was a lot of pressure. I think it's tough for any junior faculty member.

Back then, there was no mentoring program. I did not get good mentoring. There were no official mentors. I had to be entrepreneurial and proactive and go around and set up appointments to talk to the people who were senior and knew what was going on. I don't think that situation got better for junior faculty until the mid- to late-'90s. Now there is a formal mentoring program, there's much more guidance. The groups and areas take better care to make sure junior faculty know what's going on and get feedback. Back then, it was a black hole.

B: You also mentioned that system dynamics was moved? Say more about it.

J: Right. When I first joined, there weren't areas. One of Abe's organizational changes, early in Abe's tenure as dean, was to create the areas. Then the question became, "Where would system dynamics be?" Obviously it wasn't going to be in EF&A so the question was, "Is it in Management Science or is it in BPS?" That was tricky because it's interdisciplinary. We use OR techniques, we build simulation models, and our students take graduate-level technical classes in OR and control theory from the engineering and math departments. They also learn social sciences because we're building models of social, human

systems. So they also were taking all the BPS doctoral-level classes in organization theory, ethnography, sociology, etc.

I don't recall how the decision was made, but we ended up in BPS. I sat with the social science people up on the fifth floor of E52 for most of the time I was a junior faculty member. That was a great experience. I got a lot of exposure to cognitive and social psychology from the micro people in org studies; John Carroll, for example, ethnography from Van Maanen and folks like that. Ed Schein had a very important influence on system dynamics. Process consultation in Ed's work was hugely important. You, Bob.

In fact, sometime in the 1990s, Peter Senge, Bill Isaacs, Ed Schein, Chris Argyris and I organized and ran a seminar series that went for several years specifically to explore the synergies between the so-called "hard" and "soft" sides.

J: We strode between the hard technical side of the Management Science area and the softer side of BPS, although I don't like those distinctions. Or, as Ray Stata said "The hard stuff is easy; it's the soft stuff that is hard."

Being in BPS was a great experience. Later we moved to Management Science, largely because whoever was dean at that point said, "System Dynamics needs to be part of a bigger group." I didn't really see the need for this. What were the options? The options were the Strategy group or Operations Management. At that time, the key people in Operations were Gabriel Bitran, Tom Magnanti, and Steve Graves, and they wanted the System Dynamics people to affiliate with them. The Strategy Group wanted us, too, but that group wasn't as coherent and suffered from some in-fighting. We chose to go over to Management Science, and we were there for many years.

B: You physically moved over.

J: We physically moved over to E53. It was a horrible building. I continued to stay connected with BPS. Later, when Nelson Repenning joined the faculty, we became and still are members of what's now called the Work and Organization Studies Group BPS. So we were in

both Organization Studies and Operations Management. A lot of people would just scratch their heads, "How can this be?"

I felt straddling BPS and Management Science was really important. Our models integrate aspects of both. I would go to Operations Management workshops and conferences and tons of great work would be done. But my reaction and what I would say to the people is, "There are no people in the organizations you're modeling. People matter. You need to have some humans who have human behavior." And I would go to Organization Studies workshops and conferences and my reaction would be, "There's no physics in your models. You just assume that there's all these people interacting and they're not embedded in a physical setting that constrains and enables their behavior. You need to put more physics into your models." I still think this is true.

Today, not because of me, but because of a lot of people came to this conclusion, there's a very vibrant field in Operations Management called Behavioral Operations. We have Behavioral Operations people on our faculty today. And there is a lot more use of laboratory experiments with people managing simulated operational and other systems. I did my first lab experiments in the Operations context in 1988. The Beer Game is a great example of a setting that's highly relevant to operations. Human behavior is critical if you want to understand how real supply chains behave. There's now a large field in Operations Management that looks at behavioral issues; the faculty involved come from ops, psychology and organizations; they often run experiments. There are conferences, journals publish the work, and so on. That's been great.

G: There's a story I think I've heard Ed tell, that Leo Moore used to run a production lab in the basement of E52?

J: Yeah.

G: That had a lot of behavioralists, Bavelas and Cartwright, and people there after Lewin. Both Deming and Juran had come here and it influenced part of their development of Total Quality Systems.

J: I was in grade school, but that's my understanding as well. Not only that but there's a deep connection to Jay there. Jay knew McGregor very well, and McGregor had a big influence on Jay's thinking.

B: They were in adjoining offices.

J: Yeah.

G: The success of the operations teachings in Japan was not just the technical part, but the behavioral part.

J: Absolutely. The behavioral side and theory for what we now call high-performance work systems, and empowerment, and treating people with respect, were central to the original quality movement, especially visible in Deming but also in Crosby and Juran. Really, really important and I know that had a big impact on Jay as well.

B: John, you mentioned the beer game. Could you say a little bit about as the curriculum or the required courses and core and electives over the years? How has system dynamics been positioned in our curriculum?

J: Well, the beer game is really quite old. Jay's very first system dynamics model was his model of the GE appliance division supply chain. I'm sure he's told you this story. His very first simulation of it was done by hand, not on a computer. It explained what's now known as the bullwhip effect. That is, as you go upstream from final consumption to production of raw materials in any supply chain, pretty much all supply chains, tend to show fluctuations. I don't mean random variation, I mean cycles, and those cycles get bigger and bigger and bigger as you go upstream, a process known as amplification. The timing of the peaks and troughs are also lagged as you go upstream. Those three attributes—oscillation, amplification, and phase lag—were pervasive in supply chains back then, and they still are to this day in many industries.

At some point around 1958, Jay's appliance model was converted into a physical board game that was called the Refrigerator Game. The faculty at that time quickly learned that students weren't that interested in playing the Refrigerator Game. Somebody came up with the idea of calling it the Beer Game, and suddenly the students were much more interested. Of course, there's no alcohol in the game, and it's not really about beer.

I first played the beer game at Dartmouth when I was a freshman, and the game was pretty effective. I learned to run it later because I was a TA for system dynamics as an undergrad. When I came to MIT, I played it again, and I learned to run it better. By the time I finished my PhD I'd run it 10 to 20 times. I've probably run it now close to several hundred times. It's still just as effective as it was back then, probably more effective because over the years a lot of people have improved the game. The rules were changed to simplify things so you could play faster. Peter Senge, especially, came up with better ways to debrief it. I built on that and have my own effective debriefing, but a lot of that I owe to Peter. I used to run it in my system dynamics classes every term.

Then those classes became too large to do it. At some point I started to run it in Sloan's MBA orientation, the week-long program all incoming MBA students do before the start of their first term. In 1988 the MBA class was growing, and they created a meaningful orientation for the first time. Until then it was pretty much, "Show up and you start." They figured out that wasn't a good idea for class cohesion. I was asked and agreed to run a simulation session in the first orientation program. The first year I ran a workshop using the People Express simulation. I had built a system dynamics model of People Express, which you'll recall was a low-cost airline that became enormously successful and then went out of business very fast. People Express tried to implement what we now call high-performance work systems practices, including employee ownership. It was an extraordinarily innovative and interesting company. I built a model of the company while they were still in business, and offered to convert it into an interactive computer simulation for orientation. I spent about three months full-time and every weekend, with the help of doctoral students like Ernst Diehl, Bent Bakken, and others, converting the model into an interactive game that would work, that would be robust, that would be fun to play.

This was 1988, so you know what personal computers were like back then. It ran on a Macintosh, it was the famous little Mac SE. No hard drive. It looked like a little cube with a 9" black and white screen. We arranged for Apple to deliver 200 of these, which students could then purchase. The students came to the ballroom of the Marriott and had the chance to run their own People Express Airlines. That orientation session was the beta test of the simulator, and it worked, thank goodness. The People Express simulator proved to be extremely popular, and has since been used at hundreds of universities, B-schools and companies around the world. The issues in the case are enduring and still relevant; we're still using that simulation today, in 2013, in our classes.

B: In what classes?

J: I use it in Exec Ed. and in the introductory System Dynamics classes for MBAs, Sloan Fellows, and our EMBA students. I use it in John Van Maanen's Exec Ed class on complex organizations. It's still used all over the world. The case and simulator integrate issues of leadership, organization design, strategy, operations, marketing, human resources, and so on. The company principles and the individual policies, values and practices the founder, Don Burr, created were all individually excellent, but they interacted with one another and with the employees, competitors and capital markets in a way that doomed the company. People love this simulation, even though the company went out of business in 1986.

G: Predictively it went out of business, right?

J: Yes. I met Don Burr, and he accepted my invitation to speak here at Sloan several times.

B: That would be another topic for discussion—whether it was predictable.

J: I built the first version of the model before they went out of business, and I couldn't find any policies that I could implement in the model from that moment in 1985 forward, that could save it.

B: We also have to have a discussion when they merged with Frontier, so there's a whole other topic…

J: That was a big part of the downfall, because they bought a legacy airline that had unions and job specialization, and that was totally against its culture.

G: You have to think Southwest learned from that.

J: Yes, I know that over the years some people at Southwest have used the People Express simulation. I can't take any credit though. I don't know how they used it but a lot of airlines used it. Anyway, I ran the People Express simulation in orientation for three or four years. Then we switched over to the beer game.

G: And then the manufacturing game?

J: We did the manufacturing game, too. For two years I ran the manufacturing game, which is a system dynamics game of maintenance and safety in high-hazard industries like chemicals and oil refineries, created by a terrific group then at Du Pont, led by Winston Ledet. It's a great game, and it's had a huge impact in the real world, but it's enormously complex, logistically. We switched over to the beer game because the MBA class was getting bigger and bigger, and it just became impossible to run the manufacturing game.

B: This is part of orientation?

J: For many years now, the beer game is the final capstone event in MBA orientation. Since 1988, I've done this capstone session in orientation every year, except for one

year when I was on sabbatical and Nelson Repenning did it. This was the 25th year, and we had 400 people playing the beer game all at once. I think our orientation sessions are the largest beer game events anywhere. The students seem to really enjoy it, and it's also quite serious.

B: What I'm trying to understand is, does this wet their appetite for more work in system dynamics?

J: I think for a number.

B: We don't have a required course in our curriculum.

J: The main System Dynamics MBA class remains an elective. The first half-semester of system dynamics is now required for the Sloan Fellows, at their request. I've resisted having system dynamics be required. I'm much happier when everybody in my classroom is a volunteer and not a conscript. It makes a huge difference. I've resisted pressure from various people to embed it as a requirement. But it has been a required half-semester in the Sloan Fellows program for quite a few years now and also in the EMBA program, but not for the MBAs.

B: That's an interesting contrast.

J: Enrollment is very high. It's one of our more popular electives. We teach two sections every semester, plus there's a version that Brad Morrison teaches in the summer. We could use more faculty, we're short-handed.

B: What about PhD students?

J: I think we're averaging about one a year through the Sloan program and maybe another one or so a year, on average, through other departments. We can train more and place

them, but we're limited by the PhD fellowship budget. We always turn down many well-qualified people every year.

B: Marching along, I know that you and Rob Gibbons and…

J: Nelson [Repenning] and Rebecca [Henderson].

B: Do you want to talk about that? What stands out between starting days and today, that you really feel is important to talk about?

J: A general comment is—and it's been part of my agenda, although I don't want to take credit for this—Jay is a genius, and I don't use the word lightly. I know it's devalued and people use it all the time. But Jay is a genius. He's able to find these insights, and he's done it repeatedly. It's not the case that he got lucky once with his servo-mechanisms work, and then he got lucky again with Whirlwind, and core memory, and the SAGE air defense system. He's done it many times, in rather different domains.

One of the great things about MIT is I get to spend most of my days with people who are far smarter than I am, including a number of Nobel Prize winners in all kinds of fields, not just the so-called Nobel in economics, but physics and chemistry.

I've met a lot of Nobelists and learned a lot from them, very impressive people. Yet many of them just don't have what Jay has. The downside of that is nobody else can be Jay. The way he did system dynamics worked only for him. It couldn't work for me, and it can't work for anybody else.

You have to remember, Jay doesn't have a PhD. He doesn't need it, it doesn't matter, he's got a dozen honorary degrees. He became a full, chaired professor at the Sloan School in an era where you didn't need that degree. Jerry Wiesner invited him to join the Sloan School after Jay was at a point in his career where he thought the pioneering days of computers were largely over: the mid-1950s! He was running the digital computer division of Lincoln Labs. You could just move over and be a founding member of the Sloan School at that point.

Those days are gone, of course. The management business school industry is much more routinized and regularized and professionalized and formalized. Not as interesting in many ways.

So those of us who were Jay's students had to invent a different way of doing system dynamics. More grounded in other fields – sociology, economics, organizational behavior, psychology, operations management, and operations research. We had to know those tools and that literature. We had to make sure that our students were fully trained to the same level as doctoral students in those disciplines. And also learn system dynamics at a full, scientific level. Otherwise we couldn't be successful, and we couldn't get published.

Gradually the tide turned. The animosity that Jay had generated among people here was because he just did his work. He didn't worry about citations, and he didn't really care if other academics were upset. He was interested in the real world. He did his Urban Dynamics model because he worked with John Collins, the former mayor of Boston. I'm sure he told you all those stories. He didn't really care to talk to professors of urban planning whom he didn't think could inform much about how real cities actually operated. That approach is not a model for building an academic group.

We had to develop other ways of doing things. That professionalization was very good for our field. It would not exist without it because there's only one Jay. Today there is no substantial residue of the animosity that existed when I started. I've collaborated productively and successfully with people in operations, in economics, in organization studies, in sociology, in strategy and pretty much everywhere else. I enjoy the fact that System Dynamics is interdisciplinary. Over the years I've given weekly seminars for strategy group, the organizations group, the marketing group, the accounting group, the economics group. The only one I have never done is the finance seminar.

This interdisciplinarity leads to your question about the work under the PIMO [Project on Innovation in Markets and Organizations] project. Students would come to me, Rebecca and Bob Gibbons and say things like, "I'm taking your class and I'm taking Rebecca's class" (or Bob's class) in organizational economics. "You guys are really talking about a lot of the same things. You should coordinate." We had been a little bit, but we got together and realized that we were really doing some very similar things and there was some nice complementarity. We started taking each other's classes. Rebecca, and then later Bob, and also

Roberto Rigobon, they all took system dynamics from me. I took technology strategy from Rebecca. I sat in on Bob's, and I learned a ton from that. It improved my teaching to watch Rebecca, who is a master in the classroom. Then we got together and said: "We should do something that combines our research because we're all really focusing on similar issues lying at the intersection of organizations and how they behave, including the role of incentives and all the social and psychological factors that not only shape what happens in the organization but feed back and interact with markets, competition, and the broader world in which firms are embedded."

Bob had a prior relationship with John Reed, so we went to John, who was interested in these kinds of issues, including the teaching. We put together a proposal, and John was very generous in funding it. You've interviewed him, right?

G: Yes, twice.

J: He gave us a substantial gift, in the many millions to support our research and curriculum and pedagogical development, with some matching funds from Sloan. This has been an extremely fruitful collaboration over many years with Bob, Rebecca and me. When Rebecca left for Harvard, although we still work together, she's not formally part of the project any more. But that doesn't really matter.

Along the way we brought in Nelson Repenning. Nelson had been my doctoral student, then joined the faculty, and became a full professor. He's terrific and has made some big contributions.

I'll tell you a story about when Nelson was junior faculty. He was up for reappointment review. What's said in the personnel committee meetings is confidential, but I feel comfortable sharing this. It was his first reappointment review as a junior faculty member. He was making progress, he had had some papers out, and the first reappointment basically is just a check-in. Are you on track? What kind of feedback and guidance do you need? The chair of the review committee gave his report and ended it by saying, "In response to the question, what advice should Nelson be given?" he said, "He's hard working, he's got papers in the pipeline getting out in good journals. But his most important paper so far has been co-authored

with his thesis advisor, John Sterman, and he's going to need to establish his own identity and not be seen as standing on John's shoulders."

I said, "That's not going to get him very far off the ground!" And he did establish himself, of course. Nelson has done great work and has made important contributions to organization theory and operations. He's a terrific teacher and it's a joy to be able to learn from him. We brought Nelson into the PIMO project, and this has led to quite a lot of useful work. You've talked to Bob Gibbons?

B: We have not interviewed him. I have talked with Bob about work he's doing on relational contracting.

J: You wouldn't have initially predicted that a pretty theoretical economist like Bob would want to work with us in system dynamics, or even with Rebecca who is very oriented toward implementation and policy issues. We got along great and found a lot of complementarity in our different views. It's been very fruitful, and has led to some real changes here at Sloan and in organizations we have worked with. Our curriculum in system dynamics has improved as a result of incorporating their work. They would say the same, but you should ask them about how they teach and their theories.

It's also led to teaching innovation. One of the things that came out of it, which I led the charge on, is the development of these interactive management flight simulators. The first one was the beer game. We didn't think of it as a management flight simulator back then, but that's really what it is. The People Express simulator was the first computer-based management flight simulator in system dynamics. People Express led to the creation of many others here at MIT and around the world. These are different than the typical management simulation games that have been around, although there's clearly a relationship. Typical games didn't have a lot of dynamics, the time horizon was short, they had a lot of detail complexity. Ours tend to be focused on longer timeframes, and to compress time and space more, like the People Express story. You start flying that airline on Day One of service and you make decisions over a decade or more to see if you can make that business successful instead of having it crash and burn.

I've developed a number of management flight simulators, and with PIMO we developed a suite focusing on core issues in organizations and strategy and how they interact. These simulations are all now available free to anyone in the world through the Sloan Learning Edge website. They are all well-documented, including videos I've recorded for students. There are video teaching notes, written instructions, slides to introduce and debrief them, and everything you need as an instructor to run them successfully in your classrooms and workshops. Right now, there are six, and there are more in the pipeline. All of the simulations are attached to real case studies, so they are not abstract games. These are all original case studies that we've developed at Sloan.

The simplest is an interactive pricing game, built around the salt industry as the case. Think of de-icing, road salt, or salt for industrial processes, which together are the vast majority of the demand for salt. It's a commodity, but transportation costs are high, so there's imperfect competition. It's a multi-player game, You can run it with two people per market, up to ten. That game is now used in a variety of places, including in the core economics class for the MBAs. They just ran it last week. I trained them, and Joe Doyle and the other folks who teach 15.010, the core economics class for first year MBAs, run it. The other simulations relax the limiting assumptions of the core textbook model of competition in which it's assumed that marginal costs are constant, that there's no entry or exit, and so on. We add some of the important feedbacks that play a role in real markets. For example, "Eclipsing the Competition," the simulator based on the solar photovoltaic industry, is about scale economies and learning curves, and how competitive strategy works in a world where costs go down with scale and experience. How does strategy vary if there are learning spillovers? What happens if there's entry of disruptive new players into the solar industry? What happens if your competition plays the learning curve strategy as well?

I chose the solar industry for two reasons. First, because it's a sustainability-related case. Rather than learning about scale economies in the steel industry, let's use a context that is relevant to sustainability. That industry turned out to be important. A lot of our students, even now that the solar industry is taking off, don't know how the technology works. They don't understand how cheap it is, and don't understand that it's getting cheaper every day. They don't understand how to convert a price for modules in dollars per peak watt into a levelized cost of

electricity in cents per kWh. They learn a lot substantively, but they also learn about how a learning curve strategy works. The other reason I chose solar is that it's a prospective story, it's not retrospective. You could look back at learning curves in the chemicals industry, where there is a lot of data, but it's a mature industry, whereas solar is an industry that's going to be growing at huge rates for decades to come. It will remain an evergreen, relevant case for a long time.

Then we add multi-sided markets to that mix. There's a case on video games as an example of competition in the presence of complementary assets. You have a multi-sided market, as you do with newspapers, with advertisers and readers; or the computer industry, with operating systems and browsers; or smartphones with iOS versus Android. In the "Platform Wars" game it's X-Box vs. PlayStation. That has proved quite popular. They're using that simulation at Stanford Business School now and a variety of other places.

We've also got a game, "CleanStart," in which you create and build your own startup business in the clean tech sector. Again, a sustainability context, but it is fundamentally about entrepreneurship. As you being, you've got a great technology from your graduate work in an MIT lab. You and your roommate have formed a company and now you've got to make it successful. You have to raise money, price your product, win customers, hire people, treat them well, pay them appropriately, and get your product to market before competitors, without burning your people out. This turns out to be quite challenging. That's quite a lot of fun.

Like People Express, CleanStart enables players to build a high-performance work system, with employee ownership, if they choose. CleanStart was partially funded by Mary Ann Beyster and the Foundation for Enterprise Development. Mary Ann is a Sloan Fellow alum. Their mission is to promote employee ownership around the world. In CleanStart you can raise the money to grow your company with VC money, or try to bootstrap it and make it an employee-owned, self-financed enterprise. When does that work and what are the implications for pricing, employee compensation, growth, cash flow and so on?

Our climate simulation is also available. That simulation is not related to PIMO but it's part of my sustainability work. Working with former students and colleagues through Climate Interactive, we've created a set of interactive climate policy models that are grounded in the best available science and match the behavior of the large, supercomputer-based climate

models but run instantly on an ordinary laptop so ordinary people, policy makers, business leaders, media, educators, students can use the model and be in charge of their own learning.

The purpose of our climate models goes back to the Chip Schroeder story. We know from decades of research that you can't tell people anything, especially in an area where there are strong prior beliefs, as in climate change. In climate change, the science is settled. There's no serious doubt that the climate is changing, that human activity is largely responsible, that there are grave risks from continuing to burn fossil fuels. Yet, the public isn't on board, and policymakers and businesses, therefore, cannot take the actions needed to address the risks. It doesn't matter how good the science gets, and it doesn't matter how many PowerPoint presentations scientists make, how many articles they publish, how many news reports are posted. The science is not changing people's opinions fast enough, and for some, at all.

People can learn about complex systems like the climate when they have the opportunity to discover how the climate works for themselves. Learning doesn't happen without feedback. Normally you get feedback from experience. Jay is fond of saying—this was in that very first article of his I read in 1972, "Counterintuitive Behavior of Social Systems"— that most of our beliefs about how the world works come from experiences in which cause and effect are closely related in time and space. Touch a flame, get burned right here, right now, and you very quickly learn not to touch the flame. But complex systems don't work like that. There are long time delays. Cause and effect are distant in time and space. The impacts of your decisions manifest far away and much later. You never get the feedback that would tell you what the true impacts of your decisions are.

In an area like climate change, this is especially true. We only have one climate. We can't run experiments or learn from experience. By the time we have definitive evidence about how the climate responds to 1000 ppm of CO_2 in the atmosphere, it will be too late to do anything about it. We have to learn through simulations. That's the only way people can get experience and learn for themselves. Of course, this was the philosophy of all our management flight simulators, going back to the very beginning.

We developed that set of models and created a nonprofit organization called Climate Interactive. It's been created and run by former students of mine, and also former students of Dana Meadows. Those models have been and are used by the climate negotiators for

the US. Secretary of State John Kerry personally used the model when he was a Senator. The Secretary of Energy has personally used the model. President Obama has been briefed on it. The same model is used in colleges, in high schools, and even some middle school kids have used it. All use the same model.

What makes it work is that you are in charge. You don't like the parameters on how fast ice sheets might melt? You pull the slider and change it. You don't like the sensitivity of the climate to carbon dioxide? You change the slider and change it. And you can try any policies you want. In this way, people discover for themselves, not just the physics of the climate, but also what it would take to mitigate the risks.

B: We're getting close to the time that you need to go. You've probably covered a lot of the examples under the next question. What are you really proud about in terms of your time here?

J: As the old joke goes, a guy drives along up in Maine and sees a farmer. He pulls over and asks, "Hey, stranger, have you lived here your whole life?" And the farmer says, "Not yet." I'm not done yet. I hope and plan on being here for a long time to come. I hope I can continue to be innovative and productive and contribute. I have been on the faculty since 1981, I guess that's 32 years. I don't think I should or can take credit for any of the things we've discussed. But one thing that's been very important has been carving out my own personal style about how I do research and how I interact with and genuinely learn from people in other disciplines, rather than the Jay model. That worked for him, but only for him.

System dynamics has thrived at Sloan. That's helped catalyze the growth of the field worldwide. There is an international society, annual conferences, and a journal. Publications are growing, and influence is growing, and that's been very gratifying. There's still a lot of work to do. The quality of the work needs to improve, but that's probably true in every field.

Going forward, I'm committed to focusing my work in sustainability, which is really why I got into system dynamics in the first place, through Dana and Dennis Meadows. That's really why I started doing this. A lot of it goes back to that very first paper of Jay's about

world dynamics and population, economic growth and resources, pollution, and how they all interact.

Helping to create the Sustainability Initiative here, which we didn't talk about, but it's doing well. Seeing how much interest many of our students here at Sloan, at the management school, have in those issues. We have great students here, they're ambitious and talented and committed. Many are not yet interested in sustainability, but it's amazing how many of our students are motivated by more than just being successful financially or in their career. They want to make a difference, to make a better world. It sounds like a cliché, but intrinsic motivation beats extrinsic any day of the week. Building a sustainable future in which all can thrive is a terrific intrinsic motivation, I want to keep building that as we go forward.

I think the pedagogical innovations, which again I can't take credit for. Dennis Meadows has been a huge pioneer in interactive gaming. I learned a ton from him. The management flight simulators and getting those developed to a point where they're used by non-system dynamics people all over the world. Doing the research about how people learn, or fail to learn, from simulations. Having a great video game isn't the goal. That doesn't ensure people are going to learn. It's been partly about the artifact of the simulator and partly about developing the protocol for the learning experience. People like Peter Senge, Bill Isaacs and Otto Scharmer, Chris Argyris, and Ed Schein have contributed in many, many ways over the years.

B: You want to add or ask anything, George?

G: I've got three circles on my paper, so there are three questions from very different domains. First I would ask: do you have a systems model for how the Sloan School runs and how to be successful in it?

J: (laughing)

G: I know you do but I don't think you've articulated it.

J: I will tell you a story. I'll try to keep it quick. When Joel Moses was Provost, he contacted me and said, "I would like to have a system dynamics model of MIT."

I said, "No! Are you crazy? Why would I want to destroy my life that way?"

I met with him, and we talked about it, and he persisted. I put him in touch with David Peterson, who is an MIT PhD alum in electrical engineering. David was a doctoral student of Fred Schweppe, and he also did system dynamics with Jay. He got his degree in the early 1970s, then founded what is now one of the main system dynamics consulting firms. David is a great guy and he and his wife Laura run the company. David, on a *pro bono* basis, offered to build this system dynamics model. Joel kind of twisted my arm and said, "Why don't you be an advisor?"

I told Joel from the very beginning, "If this model is going to be helpful in any way, you've got to bring the other senior people in the MIT administration—the key leaders from the staff side, the other academic people, facilities, the comptroller, the EVP and treasurer—into the process from the beginning, so they're participating in the model-building process. Otherwise, they're never going to accept the model, they're never going to believe it, and nothing is going to happen."

He said, "No, you build this model for me and let me worry about that."

I said, "No! That's not going to work." But I failed to persuade him.

The model turned out to be quite interesting. There's a lot of really interesting dynamics at any university, including this one. But, without the engagement of the other key leaders from the start, of course it never had any impact.

To illustrate, David Peterson interviewed all the key people at the Institute. I won't name any names, but he interviewed one person in a very senior staff position, and had been there for many, many years. This person asked, "So what is this about?" and David answered "Joel is building a simulation model to help him think about how the Institute works as a complex system."

This guy leans back in his chair and says, "Listen. Provosts come, provosts go. I'm going to be here long after he's no longer provost and is just a professor back in a department."

Of course that was exactly what happened. Again, you can't tell anybody anything; people have to learn for themselves.

B: Sounds like Bill Dixon.

J: I'm not naming any names! I'm neither confirming nor denying. But it was a funny thing, because I had this interaction with Joel on this question many times, and at the end of the day, he just did what he wanted to do anyway. Why? Partly because I was telling him it wasn't going to work, instead of having him discover it, which he ultimately did, for himself. But of course by then he was no longer Provost. So, no, I have no Sloan School model and I'm never going to build one.

G: My second question is this: the school is changing a lot, and it has made certain choices in terms of what it offers for its programs. Our main MBA program has been critiqued as not being too much different than anybody else's. I know from John Reed's perspective, certainly, that he had hoped to have a greater impact and change. He has some concerns and is obviously very influential. The question is: where do you see the program?

J: It's quite true that over the 32 year that I've been here, Sloan has not only grown but it's also gotten much more similar to other MBA programs, and those other programs have gotten much more similar to one another as well. The whole industry has converged on a dominant design with minor variations around the edges. The elite schools—Harvard, Stanford, Wharton, Chicago, and Sloan—all look pretty similar. I don't think that's entirely a good thing. It's been going on for years, and it's not because of any one dean or person who made a decision, good or bad, to do this. It's because, as in the beer game, if you put people in a system they're highly likely to behave the way the pressures in that system compel them to behave. The pressures in the business education system have been toward standardization, routinization, and substitutability; towards competing on GMAT scores for entering students, placement stats, starting salaries, and other easily measurable factors that may not reflect what really matters if we are to fulfill our mission to develop "principled, innovative leaders who improve the world."

We've lost a lot of what made Sloan distinctive and different from all other places. It used to be there was no MBA degree, it was an SM in Management for many years. That changed after our students and applicants, and potential applicants, were objecting that in the job market nobody knew what an SM in Management from MIT-Sloan was. They were putting MBA on their CVs when they were in the job market. We recognized that and changed the name of the degree to MBA.

Then the thesis went away, and the core changed slightly, though not much. It's incredibly resistant to change. It became a lot harder to design a more personalized, quirky program. I think that's been a loss.

I think our students are great. System dynamics remains one of the really unique differentiators for Sloan in the business school world, and it's perfectly placed here at MIT. I can imagine a system dynamics program at the Harvard Business School, but it would be very, very different and hard to sustain. It would be much more of a lock-step program. They get incredibly talented students there, but I would not trade our students for theirs.

Having said that, there has been a major shift in all the business schools away from "This is the last two years I'll be in a formal full-time educational program before I embark on a career. Let me learn as much as I can." Instead there's been a shift toward more of a Spencian model, that business school is a credentialing opportunity, the goal is to get a job, and classes don't matter. We see this in grade inflation, in the reduction in the number of units people are allowed to take, and in the amount of time students put into learning. At some schools there's a lot more socializing and partying—they call it "networking" of course. It wasn't like that when I started here.

G: They're not sleeping longer.

J: They're not sleeping longer, and while some are partying more, most of our students are very busy with substantive work. There is a lot more, "I'm doing a startup while I'm a student. I'm running an NGO that I founded while I'm a student" The students doing that are great, and they are learning critical lessons that classes may not deliver. I had two students this semester who told me they loved the class, but they were dropping out because their startup is

consuming all their time. Great! More power to them. If they need to learn system dynamics later, they'll come back and figure out how to do that. If they don't, fine. But there has been this troubling, plain vanilla trend. This trend toward the Spencian labor market model—you know that model?

G: No.

J: It was one of the reasons Michael Spence was awarded the pseudo-Nobel in economics. A long- standing issue in labor economics is why people go to school for training when it has huge opportunity costs. The traditional theory is it gives you skills that make you more attractive to employers and increase your future earnings more than the up-front cost (in a net present value sense). In that world, you should work hard in school to learn as much as you can so you will boost your skills and attractiveness to employers. That didn't seem quite right, so Spence built a model in which he said, "By assumption, let's construct a model in which education does nothing, it doesn't augment your skills, and doesn't give you any better capabilities. You come out with no greater talent or ability or knowledge than you went in." So why would people go to school?

The answer in his model is: "Imagine that there are two kinds of people. There are people who are willing to work really hard, and people who are not willing to work hard. Employers can't tell who is who. They need a sorting mechanism, and school is the sorting mechanism. In order to get into and graduate from a top school, you have to be willing to work hard. If you're not willing to work hard, you're going to be at the bottom of the class or you won't get in at all. So once you are accepted to a top school, then you've got the golden ticket that signals to employers that you are a hard worker; you've demonstrated that you are willing to cram for exams, put up with a lot of useless classes and so on. In that world the function of business school is to get that diploma, not to learn."

It's the Wizard of Oz, right? The scarecrow wanted brains but that actually turned out not to be necessary; all he really needed was a diploma. In that model, you shouldn't study because you can't learn anything. In that model, you shouldn't spend any time on the curriculum.

You should spend all your time trying to get a job, build your network, and prep your resume. That is what happened in the business school world to a disturbingly large extent.

G: And it's self-fulfilling.

J: It's absolutely self-fulfilling. We haven't gone all the way down to the equilibrium. We're not the University of X on the web diploma mill. But there has been a shift. I don't think we should blame the students. They are incredibly talented and energetic people, at least the ones I interact with the most; it's a joy to be around them. A lot of the responsibility for this trend I think is on us as faculty. We're teaching in ways that don't work.

G: Is the larger system always going to drive them back to that behavior? Which is what the Spencian model would suggest?

J: I don't know. More and more students believe they aren't going to learn anything from their classes so they should work on their startup, or build their network, and basically spend two years creating the job want. We're responsible for that as faculty. The business model for a business school is large classes, so the faculty can be very well compensated. And in large classes, learning is very difficult. HBR has section sizes of 85 or something like that.

B: 90.

J: 90 now?? That's crazy!! Even though they have terrific faculty teaching, and they cold-call people, you're not going to be able to have meaningful participation, decision making. Lectures and case discussions in such large classes are performances in which the faculty are the stars. As when you go to the theater, you can admire the actor's performance, even be moved by it, but you aren't learning how to act yourself. There isn't any learning happening in a lot of those classes, including the big lecture classes we have here. To fix that requires some very radical changes in the business school model, and I don't think massive on-line open courses are the answer. Alison King published a famous paper in 1973 in the journal *College Teaching*. The

title sums it up: "From Sage on the Stage to Guide on the Side." If we want our students to value what we offer we need to help them develop their capabilities, not charge them a fortune to attend performances, no matter how great they may be.

B: You'd better go with your last question.

G: This is my last question. I mentioned to you my interest was to understand the School and the way it was when it innovated significantly. The project that you, Bob and Rebecca, and now Nelson, have done has those characteristics. I haven't seen much else of it. Would you say that you're unique, or am I just not seeing some of other partnerships that are doing what you guys have done?

J: I think this is happening in the sustainability area. I'd like to think it's happening in other parts of the school, but I'm not part of those projects, so it's hard to say. I wouldn't want to speculate right now, but there's a lot of exciting things going on. Retsef [Levi] is running his healthcare initiative. I'm peripherally involved in that, so I see that a little bit. Bob's been participating in that too.

G: It was things like Jay Forrester and Douglas McGregor and Doug Brown and some of the influences that moved fields along. Of course it was a time when there was less choice and less available, so those things had a bigger impact.

J: I don't want to come off as sounding like "back in the old days we were tougher, we walked to school barefoot in three feet of snow every day and it was uphill both ways." It must have been a lot more exciting when McGregor was here, and when Ed Schein was new to the faculty, and when Jay was creating system dynamics. There were some really big, new ideas that opened up. There have been some tremendous big new ideas over the years here at Sloan.

The management education business has gotten more routinized. You look at the journals, there's a lot of well-done but uninteresting work. Jay was never interested in that. I quote him to the students all the time. There's an appendix in *Industrial Dynamics*. Here's this

technical book full of equations. How do you build a model of a company? And there are all these appendices on technical issues about numerical integration and so on. Then the last appendix, Appendix O, starts off talking about courage. Jay says "Industrial dynamics is an approach that should help in important top-management problems." "The expectation should be for major improvement in the system." "Very often the most important problems are but little more difficult to handle than the unimportant. Many [people] predetermine mediocre results by setting initial goals too low." "The expectation should be for major improvement in the system." "The goal should be to find management policies and organizational structures that lead to greater success."[1]

I don't see as much of that kind of courage. And I'd have to say that applies to me to some extent. It's not easy to be bold and courageous.

B: That's probably the right place to stop. This has been fantastic, John, to understand your story. You've made an incredible impact here.

J: A pleasure. Like I said, 'not yet!'

[1] Forrester, J. W. (1961) "Appendix O: Beginners' Difficulties," subsection, "Courage." In *Industrial Dynamics*, Cambridge, MA: MIT Press. Page 449.