MARK EISNER: Hello, I'm Mark Eisner, a member of the INFORMS History and Traditions Committee. I'm here today with Jack Muckstadt, Professor John A Muckstadt at Cornell University, to discuss his career and operations research. We are in the building that was formerly the home of President Andrew Dickson White at Cornell and is now the Society for the Humanities. Jack, thank you very much for agreeing to do this.

JACK MUCKSTADT: It's my pleasure.

MARK EISNER: We like to start these interviews with discussion of early days and your upbringing and so on. Can you tell us a little bit about where you're from and your family and so on in that place?

JACK MUCKSTADT: Indeed, I was born and raised in Rochester, New York. I was born in 1940. And some of my earliest remembrances were about World War II and the ration books we would go to the store with, which I still have. And the consequences of that era has played an important part in how I've thought about life.

We lived in relatively what we call existence mode. We didn't have lots of material things, but we had our family and it was a great time. And those things have carried over for me in my life. So as I got older, we went to school, the neighborhood school, went to the same high school that my parents went to. And in the grammar school, I had two teachers that my father had. So it was it was a community, a long term caring environment in which we grew up.

MARK EISNER: Where your parents also from Rochester?

JACK MUCKSTADT: Yes, they both were born and reared in Rochester and, basically, I think lived in about a square mile of where I grew up. We actually lived in a home with my grandparents as part of those times when resources were considerably less than they are today.

My grandparents came from Europe around 1900. These were my father's parents. My other grandparents, their families have roots, went back to the Revolution. So they were here a long time. So after high school, right after high school, my wife and I got married. We were high school sweethearts. And I spent a freshman year at Gettysburg College. And then because we were married and we were expecting a child, we moved back to Rochester. And I transferred to the University of Rochester from which I graduated in 1962.

MARK EISNER: Did you have siblings?

JACK MUCKSTADT: No, I had no siblings, no siblings.

MARK EISNER: And your wife is Linda?

JACK MUCKSTADT: My wife is Linda. That's correct. And her family also grew up in Rochester area. So it was very much of a community kind of thing. And it was nice because all of our relatives were in walking distance more or less. We didn't live the kind of life that I see my grandchildren living in where they have maybe multiple iPhones and all kinds of things. In certain cases, they have their own cars, whatever.

And we didn't have a car until I was 10 years old, and we didn't have a telephone either. So as I said, the world is quite different than it was when I was a child.

MARK EISNER: What was your parents' occupation?

JACK MUCKSTADT: My father worked at Kodak. He was a laborer there and worked in their chemical division and helped make film.

MARK EISNER: I remember film.

JACK MUCKSTADT: When I was in college, another difference between now and then was now I ask the students what are they going to do on break. They're going off to exotic places. And so they asked me, what did you do during break? I said, I got a job.

MARK EISNER: Always the same job?

JACK MUCKSTADT: No, not always, but the job just because you wanted some income. So it's a different world, different world.

MARK EISNER: So was there anything in your high school years that forecast your involvement in operations research?

JACK MUCKSTADT: Well, I won't say it was my high school years from the educational perspective. But I do remember looking at the traffic flow in the downtown Rochester and saying to myself, this is a mess. So I had a map. And on this map I drew what I called a loop that went around the city and how it would intersect with various places. And so you could divert the traffic to go around

the city and get off at places.

And by the time I graduated from college, they had built this system. So I guess the answer is yes, that even though I was just fumbling around--

MARK EISNER: They didn't have access to your plan.

JACK MUCKSTADT: No, they'd had no access to it. But it was interesting that somebody finally figured out the congestion had to be eliminated. So I studied mathematics at the University of Rochester. And I decided on mathematics for the following reason. Well, there were actually two reasons.

Number one, I couldn't read very quickly. So homework assignments in mathematics were usually six or seven pages a day. So I could read the material. But more importantly, I decided after taking courses in liberal arts-- and I was a liberal arts major-- that most of what I was studying was interpretations by people about events.

And in other words, other than facts, which you could have had in 1789 in the Constitution, something like that-- these are facts. But interpretations of these facts were all basically opinions. And so I decided what I would do is I want to study something where something was either true or not true. And that was mathematics.

I was also in ROTC, which turned out to ultimately be a stroke of incredibly good luck. And at the time, the draft was on. So lots of people were being drafted anyway. But also jobs were not plentiful. And as a consequence, having the ability to have a known job when you graduated was important.

But when I did graduate, I was the top cadet in the Air Force ROTC. And as a consequence, at that time the Air Force was sending people off to graduate school who had that distinction. So I ended up being assigned by the Air Force-- this was kind of interesting when you talk now about college admissions and taking exams.

I had military orders to attend University of Michigan. And I did do some formal application, but I don't think anybody ever looked at it. And I showed up, and four years later I had a PhD.

MARK EISNER: So you got out of college in 1962. So this was really before things heated up in Vietnam.

JACK MUCKSTADT: That's right.

MARK EISNER: And there was still ROTC universally on campus.

JACK MUCKSTADT: Yeah. Well, at the University of Rochester there still is ROTC. And it's always continued, although the Air Force has long since departed. Many of the Air Force ROTC programs have diminished in size for a number of reasons. Basically, they don't have enough scholarships as opposed to what the Navy does.

MARK EISNER: Now you got a PhD at Michigan, but you also got two master's degrees.

JACK MUCKSTADT: Yeah, well, along the way, you take all these classes. So you might as well pick up all the degrees.

MARK EISNER: Right, but they were two very different ....

JACK MUCKSTADT: Yeah, so as I said, I had an undergraduate degree in mathematics. So you couldn't, at the University of Michigan, get a master's degree in industrial engineering unless you had an engineering undergraduate degree. So they had this other program which they called industrial administration, which we took the same classes. It was just-- in fact, what I found out it was because I really did understand something about mathematics at a level that most engineering students don't have that the graduate classes were really pretty easy.

But again, that was just a stroke of luck that I had taken all those classes that prepared me to take the probability and statistics and optimization classes, almost all of which I took in a math department, though, because there were very few courses offered in engineering in those topics.

MARK EISNER: Were there distinguished individuals in OR that you came in contact with?

JACK MUCKSTADT: Well, there were several. Well, of course, Bob Thrall was the optimization guru at the University of Michigan. So we took classes with him, and he was on my doctoral committee. And Herb Galliher really developed a lot of the early inventory models while he was a professor at MIT. And then he came to the University of Michigan. It was an interesting time with the two of them. They were really smart guys.

And there were a lot of-- I mean, the industrial engineering had really moved into operations research or what I would call something beyond the rules of thumb kind of thing. It's about the time that I was enrolled there. And in fact, the first PhD I believe at Michigan in industrial engineering was in 1960. So it wasn't that long before.

And then other person that had a big influence on me was Ralph Disney. So he got me very interested in queuing theory and applied probability. My doctoral advisor was Dick Wilson, who academics would not know, but he was an engineer before he came back, and he was the one who actually got the first PhD at Michigan.

MARK EISNER: So what was your thesis on?

JACK MUCKSTADT: Scheduling in power systems. So this was sort of the beginning of my understanding of what it was to be an operations researcher. Obviously, we did some interesting work in terms of the application of probabilistic models in an environment that is in fact governed a lot by uncertainty.

But the thing that I learned was that it's probably a good idea to actually go out and talk to people who run power companies rather than just reading the literature. So there were two companies, Detroit Edison and Consumers Power, that we went and visited and talked to them about how they did things and went to generating plants and saw how all this stuff worked.

MARK EISNER: Was that at your initiative--

JACK MUCKSTADT: No, this was the great contribution my advisor made to my education. I mean, the rest of it I basically did on my own. But this was an interesting idea. And so we went ahead and built this model. It wasn't all that practical at the time. But it did have the elements in it that were-- a forerunner of some work that I did subsequently with a student here, Sherry Koenig I'll get to in a moment.

So immediately leaving University of Michigan, I was on the faculty of the Air Force Institute of Technology, which is a graduate school - the Air Force runs it at Wright Patterson Air Force Base.

MARK EISNER: And that's in Dayton, is it?

JACK MUCKSTADT: Yeah, it's in Dayton, Ohio. I was on that faculty for several years and then moved over to literally across the street to the headquarters of the Air Force Logistics Command and spent basically the remaining time both on active duty and reserves working in an office, some of which I led it sometimes. But afterwards, in reserve I was just one of the guys.

MARK EISNER: At what point did you get your commission? Was that just when you graduated from

Rochester?

JACK MUCKSTADT: Yes.

MARK EISNER: And you were at that point--

JACK MUCKSTADT: I was a second lieutenant.

MARK EISNER: Second lieutenant.

JACK MUCKSTADT: So getting back to the important things of the Air Force-- so when I moved over to the Air Force Logistics Command, it was 1970. And the Air Force was introducing this new fighter plane, the F15. The F15 was the second of airplanes that were designed to improve its maintainability, which means that I can get the aircraft back into a serviceable condition quickly.

And the way you did that is having modules in it which we could, instead of trying to fix the airplane, you were going to fix the module back in some shop. And you would swap modules like a radar set or some other thing and just replace them on the aircraft. So the methods that the Air Force had used in the approved Department of Defense algorithms for computing how many parts you need produced almost all zeros for all these components. And the system program office recognized immediately that this was probably not a desirable thing.

So I was in the position to observe the consternation that was on the part of many people and did something that all people in the military are advised never to do. And that was I volunteered to solve the problem.

MARK EISNER: And did, I suspect.

JACK MUCKSTADT: And I did. And the basic math, although it's been reprogrammed, some of which Peter Jackson and I did recently-- I mean, it's been basically used since 1970 in the Air Force.

MARK EISNER: Not just for F15s.

JACK MUCKSTADT: Not just for F15s, for all the aircraft, and by some of our allies. And roughly speaking, over this period time-- now it's a long period of time. But these models have probably been used to purchase over a trillion dollars worth of inventory.

So in some sense, this is I think one of the accomplishments of operations research, that we have affected the way the operation of a major activity is conducted.

MARK EISNER: It's quite an impact.

JACK MUCKSTADT: Yeah, I think it's something of which I am proud. But most importantly, though, I had the opportunity to do this because of the people with whom I worked. And that's another important lesson, which is not something we teach that much about. But the importance of working in groups where the team's efforts count more than the individual's activity.

So in other words, we had a problem. Now for the most part, what I did on that one I did by myself. But there was another fellow who worked with me. He had been a student of mine at the Air Force Institute. And so the two of us, he and I did the programming together, although I wrote the math.

MARK EISNER: Was there a bigger team of which you were a part?

JACK MUCKSTADT: Well, initially it was me, and this other fellow was working in another part of the headquarters, the engine shop. And because of the success of this, we -- I won't say rapidly, but there were a number of other people were assigned there. And we had a nice group.

MARK EISNER: What was the name of the group? Did it have an OR related name, do you remember.

JACK MUCKSTADT: No. There was another group, operations analysis group in another part of the headquarters. But I was part of an organization, which I've forgotten its name. But its symbol was MMX, it was material - MM stands for material management and I forgot what the--

MARK EISNER: That was the tenth one perhaps. So by that point, what rank had you--

JACK MUCKSTADT: Well, by the time I left active duty, I was a major. And ultimately, I worked in the reserves for a good period of years. But during that period of time I was on active duty - I don't want to gloss over this point, because I left active duty in 1974.

But from the years of 1968 up through 1974, I had interactions with colleagues at the RAND Corporation, and that turned out to be as much a part of my education as anything. Now why do I say that? Again, RAND is a think tank, but they had what was called Project Air Force. And of course, before I got there, they had project SCOOP in which we developed linear programming, and a lot of these other tools that are the basics of our business.

But my involvement there with these people was mostly with people who were psychologists - they were not classic operations research people. Now when I was a student of operations research, people talked-- and I emphasized talked-- about the interdisciplinary nature of the field and that you had to understand how people think and, hence, psychology was an important part of all this.

Well, OK, that was all nice in the classroom. But what we did in school, of course, was study mathematics and how to program computers and that [sort of] thing. So at RAND, I found out the importance of this-- because we were interested in solving operational problems, trying to understand how things work.

So I knew, in some sense, at that point was one of a small number of people who had really degrees in operations research. So the part of RAND I worked for was called the management sciences department. But the management sciences department had very few people in it who had the kind of academic training that we now associate with operations research. They were mostly psychologists.

MARK EISNER: Were there people who did have OR training?

JACK MUCKSTADT: Yeah, well, like Kip Miller and then we see another Cornellean.

MARK EISNER: That's Louis Miller?

JACK MUCKSTADT: Yeah, Lou Miller.

MARK EISNER: Is at the Miller of--

JACK MUCKSTADT: Conway Maxwell and Miller. That's right. I don't want to get diverted here. And there were a few others, too, whose names are now escaping me. But they didn't do the logistics kinds of things that I did. The RAND guys, when there was some mathematics or modeling or software they wanted to have developed, I got the responsibility of doing it.

So I did some of that while I was on active duty. But then in 1974, when I left the service and left active duty, I became a consultant to RAND and I spent summers working at RAND for several summers, which would turn out to be very enlightening, shall we say. So my life has

been blessed with good fortune in many ways.

So a couple of the ways I've already mentioned: I was an ROTC student, and they sent me to Michigan to go to school. I taught at the Air Force Institute. And I'll come back to that again in a second. But then I got to the Air Force Logistics Command Headquarters, and here was this problem that needed solving, which I fortunately was able to solve. But that's how I got my job at Cornell, too, from that work.

MARK EISNER: That was in 1974.

JACK MUCKSTADT: And that was in 1974. As opposed to the arduous process that people go through now to hire somebody, I came on a March afternoon to give a Tuesday seminar. And on Thursday evening, we got back to Ohio. And I had a call from George Nemhauser, and he offered me the job. So I don't think they can do that in two days any longer. It's takes somewhat longer. That actually surprised me. But anyway--

MARK EISNER: Well, you had already made your mark with the work.

JACK MUCKSTADT: Yeah, that's right. So it was interesting. But I wanted to go back to the Air Force Institute and my good fortune. I taught a student there, Bob Mortenson. And Bob ultimately went on in life, and I never saw him again. But he had a friend who was an officer in the Navy who was responsible for parsing out grants from the Office of Naval Research.

And so this guy called me one day when I was on the faculty here at Cornell and asked me to write a proposal for a grant. And he told me why he had contacted me. So I wrote this thing, and I got this grant. So at the time, the Navy was trying to get people in various fields to assist them in times of need.

So if they had a problem, they could call upon you. That was part of the provision. So there were two people doing inventory work, Pete Veinott and me. We were the two guys doing this.

MARK EISNER: Pete was at Stanford?

JACK MUCKSTADT: Pete was at Stanford, right. And by the way, Pete preceded me at the Air Force Logistics Command.

JACK MUCKSTADT: So it was part of his education, too. So I got this grant. And they also ended up paying my Cornell salary, my academic year salary. The fact that I got this grant and am paying my

salary, I think was a major contributor to my getting tenure because the number of students I was supporting on that grant was probably half the students who were supported on grants.

MARK EISNER: You put this all down to good fortune, but I think there's more to it.

JACK MUCKSTADT: Well, yeah, but, understand, these events-- one of the things on the last lecture I give to the students every year, as I said-- you're going to do well in life. Then the question is, when you get to be my age, will you have done any good. But your doing well and doing good are going to depend on your taking advantage of opportunities as they arise. So be careful. You should do all these things.

MARK EISNER: I had a teacher who said opportunity favors the prepared mind.

JACK MUCKSTADT: That's true. Nonetheless, I still believe I was very fortunate. So now we've arrived at the time 1974 when I came to Cornell. In fact, I should say how I ended up coming for that March interview. One of my sons was going to have a birthday and wasn't that far. And our family lived up in Rochester. My wife's family lived in Rochester.

So Bill Maxwell called and asked me if I would like to come and give a talk. And I said, oh, sure because I figured, oh, great. They'll pay for the family to come up, and we'll go visit our family. And I'll come down and meet and Maxwell, since I had never met them before, and Ray Fulkerson and George Nemhauser, and lots of other guys, very famous fellas.

So I came. And, as you told me at one point, that at the end of my talk Bill Maxwell came and asked the students-- and you reported this to me, that he asked the students, what did they think of the talk. So it was kind of an interesting point of view that students participated in the kind of feedback about-- I didn't know I was there for a job interview. I just came in to do this, and then they offered me the job later.

At any rate, so I mentioned George Nemhauser called me on a Thursday evening and offered me the job. And I took it on the spot without really as much forethought as I might have. First of all, I didn't realize that they hadn't tenured anybody in over a decade. But I didn't know anything about that because, in the Air Force, you just did your work and you got promoted.

But on Friday night, the day after, I got a job call from the University of Michigan. But I had already taken the job at Cornell. I mean, in retrospect it was wise choice. At the time, I probably would have chosen to go to Michigan.

MARK EISNER: You came here as an associate professor?

JACK MUCKSTADT: I came here as an associate professor. That's right.

MARK EISNER: With tenure?

JACK MUCKSTADT: Pardon.

MARK EISNER: With tenure?

JACK MUCKSTADT: No, no. No, on a five year contract.

MARK EISNER: I see.

JACK MUCKSTADT: And about four years into the five years, I was up for tenure, or something like that. And interestingly, as opposed to what I think happens now, at least it didn't happen when I was the Director of our school. I know people at Xerox and people at RAND and people in the Air Force were asked to comment about my qualifications.

MARK EISNER: Not just other academics. It was people that you knew.

JACK MUCKSTADT: So it was kind of a different world view at the time.

MARK EISNER: So you came to Cornell in 1974, and there were a number of, as you mentioned, distinguished individuals on the faculty. Can you tell me about them?

JACK MUCKSTADT: Well, there's much to tell. But I will focus primarily on the person with whom I interacted most closely for the first four or five years that I was on the faculty. And it was Bill Maxwell. And I mentioned about the lesson I learned at RAND about going in the field, looking at things, understanding how people view what you were thinking about, how did they find your opinions so you could modify them.

So what Bill liked to do was go to factories. And we wandered around lots of factories. So it was several years of collaboration. We were - Bill was on sabbatic at the General Motors tech center. And he was interested in-- we were looking at how production planning was done. So

we had been toying around with various versions of MRP, Manufacturing Resource Planning.

And what we found in looking at two plants-- one was in Michigan and the other one was in Chicago where General Motors had stamping plants. And the management of these two places were approaching the problem in a quite dissimilar fashion. And so we were trying to understand what the attributes were and what the consequences were of these two distinctly different approaches.

So to make a long story short, one of them was doing something that was based somewhat on EOQ logic. But the logic was the following: I'm going to produce a part every week or every two weeks or once a month. So we said, this can't make any sense at all. So Bill and I sat there for a long time and figured out what ultimately we called the Power-of-Two policies for planning inventories and production.

And it turned out it was a really nice piece of work. But we never would have done this if we hadn't gone into a field and observed these people. So, again, going back to my Air Force, why did I do what I did. There was a problem there. When I came to Cornell, I got these grants that I mentioned. But I also almost immediately got work with Xerox doing planning of parts that they would have for their tech reps, the people that go fix Xerox machines.

MARK EISNER: How did that contact come about?

JACK MUCKSTADT: Well, it came about because of the work that I had done in the Air Force.

MARK EISNER: So they contacted you?

JACK MUCKSTADT: They contacted me, yeah, all my consulting work, I never looked for any. It was always because somebody contacted me.

MARK EISNER: You have an extraordinary list of firms that you've worked with.

JACK MUCKSTADT: Yeah, but let me get back to my colleague Bill Maxwell. And so Bill and I worked on a number of projects together, including some consulting work at Xerox. So it was a very important time for -- I think -- for both of us in the sense that we had a lot of fun working together, but we were engineers. I realized that ultimately I was not an academic operations research, but I was an engineer, because I was interested in systems. I was trying to understand how the systems worked. And I was trying to understand ways in which we could improve those.

Now much of it had nothing to do with mathematics, I began to learn. A lot of it had to do with what I learned from my RAND colleagues, which I'd like to switch over because, remember, they were doing these things more or less at the same time.

MARK EISNER: Your RAND colleagues, is that what you said?

JACK MUCKSTADT: Yeah, RAND.

MARK EISNER: RAND colleagues.

JACK MUCKSTADT: So as I mentioned, I went and worked there during the summers. And what I worked on was, there was a whole range of interesting operational problems. But as I mentioned, these folks, they were all psychologists. But the one who was probably the most well-known was Murray Geisler. And he was, I think, the first President at TIMS or one of the first presidents.

MARK EISNER: One of the first presidents.

JACK MUCKSTADT: So he was a great inspirational guy. He talked to me about lots of life lessons, things that I should pay attention to. But he also was very helpful in making sure that I wrote papers in a way would get them published.

MARK EISNER: Published at RAND or published in journals?

JACK MUCKSTADT: No, published in journals. No, at RAND, I published a lot-- not a lot, but several papers at RAND - every summer I did a couple. So I was still in the Air Force, in the Air Force reserves at the time. So one of the problems which persists today is there are shortages of manpower, skilled manpower at the senior non-commissioned officer level who are responsible to keep airplanes flying-- so a very serious problem.

So just take the very basic queuing idea that, if you can consolidate things so, instead of having five waiting lines, you have one waiting line, you somehow get something that's going to work a little better.

MARK EISNER: Like the bank line.

JACK MUCKSTADT: Yeah, which we still haven't figured out why we do this at the borders and everybody gets in their own line. And it's goofy. But anyway, the idea that we were working on or that I promoted

at the time was that we should centralize what was called intermediate repair, which is the repair of avionics items-- radar sets, that kind of stuff.

And when you had small numbers of airplanes in various places, the manpower requirements to do the repairs was too substantial. And plus, now the equipment was getting more expensive too. So in order to get some volume-- and anybody who has done any home repair jobs knows that, if you do them frequently, you'll probably do them quicker and you do them correctly. So a lot of these repairs, they didn't occur very often at a particular location. So the skill levels weren't up to what they needed to be.

So to make a long story short, we consolidated. So my RAND colleagues said, but you're going to introduce another echelon into this repair system. And that's going to cost a lot of money from an inventory perspective. And I said, no, it's not. Its going to reduce inventories. And I attempted to explain to them.

So I spent one summer writing the math up for it and writing the computer codes, which was also a lot of work, and testing the ideas. And lo and behold, what I said was right. And so: the Air Force now has what they call CIRFs, Centralized Intermediate Repair Facilities. Now I'm not claiming it was because of me. But it certainly followed right after I had done this work. And these RAND guys had a lot of influence in the Air Force. They put forth ideas many of which were rejected, not for merit, but because, like all organizations, politics comes into play.

MARK EISNER: So this was in the '70s that this work was being done.

JACK MUCKSTADT: This would have been in the late '70s, '78, '79, something like that.

MARK EISNER: RAND had already begun to diversify somewhat.

JACK MUCKSTADT: Oh, RAND was well diversified. A good portion of the activities were now associated with policies for the state of California. Now I didn't interact with any of those folks. I mean, Project Air Force was pretty small. I don't know how many exactly, but we're talking about something certainly less than 20 people. There were fewer than 20 people.

MARK EISNER: Did you have contact with the math department or the economics department in any way at that time?

JACK Well, they had a matrix organization. So even as I say that, at that time, that was a novelty.

MUCKSTADT: They had people who had projects, like Project RAND, and you had people from economics, management science, and other things. And the projects pulled people from these various disciplines.

So as I said, my paycheck, I think, came from the management sciences department. But I worked on this Project RAND, or Project Air Force, I should say. So interesting.

MARK EISNER: Are there any of the people whose names have become prominent?

JACK MUCKSTADT: Well, besides Murray Geisler, I don't think that people would know them, because a lot of what they did-- they didn't publish in the open literature. You'd have to read the RAND reports. But they gave me chances to work on things that were interesting intellectually and also of operational significance.

But my work with RAND all ended when I went on sabbatic in 1980. And I got off on other things. And the other thing I got off on, then, was when I returned home. So one has to reflect on 1980. Of course, it was still the Cold War going on. But if you went to your local bank and deposited some money in the bank, you were going to get 18% interest on it as opposed to now where you get basically nothing.

And what the consequences of that was that the dollar was extremely dear relative to other currencies, in particular the Japanese yen because the Japanese banks were paying zero interest and charging zero interest. So this completely distorted the economics of manufacturing, to which we have never recovered from that, or not recovered fully anyway.

So at that moment, I became very interested in manufacturing. And because my father worked in a manufacturing plant in Rochester -- and all around upstate New York and other parts of the country, jobs were disappearing. And coming from a working class family, I realized that this is a national calamity.

MARK EISNER: Was your father still alive at that point.

JACK MUCKSTADT: Oh, yeah. My father died in 2001.

MARK EISNER: Did you discuss any of this with him?

JACK I would tell him when I was doing. Well, my father of course was very proud. I didn't want to

MUCKSTADT: get into things about why I undertook them, although this is still a motivating fact to me to this day. I think very carefully about people who, unlike us, actually have to work for a living. We live in a gilded cage.

But going back to this point about getting this program-- so we started what was called the Cornell Manufacturing Engineering and Productivity Program. And I was the first director of that program. And it was an interdisciplinary program where we had faculty from a variety of places on the campus-- so certainly in the operations research program. But we also had computer science, electrical engineering, mechanical engineering, labor relations, business school. I think those were the group.

And it was about this time that Dick Conway moved from engineering over to the business school, at least partially. And he started a program over there, too, where they had an immersion program. It was called Semester in Manufacturing at that time. And again, it was this group of people. We've talked about various topics to students in engineering, labor relations, and the business school. And we were trying to get the students to understand these problems from this multidisciplinary effect.

So you know, this is a long time ago. It's 35 years ago. And so we got this manufacturing program going, and we got some moneys from a variety of sources and companies. And we had a couple of grants from the National Science Foundation, which helped. But the real source of the money was from industry. So we had Alcoa, IBM-- a big one-- Emerson Electric, Chicago Pneumatic Tool. And I know I'm forgetting a couple of others.

MARK EISNER: These are some of the companies you consulted with, as well.

JACK MUCKSTADT: That's right. That's right. So they knew me, and I knew them. And I knew what some of their problems were. So we got things going. And I was director of that for a number of years, and I think we had some reasonable success. We had lots of students were interested in this topic and went on to go to work in manufacturing plants. I have four sons, all of whom work in manufacturing, for which I'm quite happy.

And then I gave up that position after several years. In 1987 I became director of our school.

MARK EISNER: The School of Operations Research And - at that time, it was - Industrial Engineering.

JACK MUCKSTADT: It was Industrial Engineering. And so the interesting question, of course, is how did the name change occur. Well, while I was director, I had many uprisings in the faculty around the

accreditation. So I was able to stave off the criticism for one round. The second round came along, and it got to be a little nastier. But somehow we survived that.

And then when it was going to come to the third round, it was pretty clear we were not going to make it.

MARK EISNER: That is, to be accredited with the industrial engineering society.

JACK MUCKSTADT: So I said, well, we have exactly one course in industrial engineering in our program, that we would classically call industrial engineering. So it's really not fair, or at least honest, that we call ourselves a School of Operations Research and Industrial Engineering. So we will change the name to reflect more adequately what we do. We'll keep the same ORIE, but we'll change industrial to information.

And that is proven, I think, to be correct. But we also had to change the name of the degree students get. And it was called Operations Research and Engineering. So here we had the school name, ORIE, and the students got this degree. It said, ORE. And so they all thought it was a typo or something. Well, it was my getting around having to do the accreditation the way we'd done it before.

So and that went on. And I was the director for nine years.

MARK EISNER: What do you see as your biggest accomplishment in that role?

JACK MUCKSTADT: Oh, hiring faculty without question. We have a terrific faculty, and it's just now that these people are retiring, or getting ready to retire. So it was a terrific ....

MARK EISNER: I think you also had some positive impact on the financial status.

JACK MUCKSTADT: Oh, yeah, well, true. Well, when I took over, we were broke. And again, my experience as a youth of having no money, instead of saying, oh, heavens, I have no money, what are you going to do about it, I decided I had to do something about it. And so I spent far too much time raising money.

And just to give you an idea-- I mean, it was also consulting at this time. So I found out that the day a week that Cornell permits you to consult was a significant benefit for me, not only financially, but also gave me a mental break from the world of being a director. So that period was a good period.

MARK EISNER: Well, I see from your CV that you got grants from some of these same companies--

JACK MUCKSTADT: Oh, that's right.

MARK EISNER: --which also would have helped.

JACK MUCKSTADT: Yeah, well, but just remember these grants were all so we could support PhD students. I mean, that was the only reason for getting these things. And the National Science Foundation had no money. So I was on these boards that periodically you go and read these proposals. And you have good proposals, and they can't be funded because there's not enough money. So basically, I just gave up writing proposals to NSF and you go to companies or governmental entities like the Department of Energy and got fellowships for students that way.

That was far more helpful to advance the - to get money. It takes such a long time to write the proposals than with the companies - you can call them on the phone and basically in an afternoon, you can work out something, so - much preferred.

MARK EISNER: Were you still teaching as director?

JACK MUCKSTADT: Oh, yeah. I was teaching three courses - Design of Manufacturing Systems, and the other courses that we instituted while I was director, Supply Chain Management and Inventory Control. So I didn't give up teaching. I think the most important thing-- I told you was the most important thing was hiring faculty-- but I also pointed out to faculty that, when I first became the director, one of my sons was studying industrial engineering at the University of Buffalo.

And if you looked at the curriculum, there were, except for some more real industrial engineering classes-- all the ones that we teach were in their curriculum-- probability, statistics, optimization. Now obviously, they were probably not taught quite the same way. But if you were a parent and you picked these things up and you looked at them and you said, mm, these programs, they're pretty similar. Why should I spend all this money sending somebody to Cornell versus I could send them to the University of Buffalo?

MARK EISNER: Which is a State school.

JACK MUCKSTADT: Which is a State school. That's right. So I told the faculty this. I said, the most important thing I have to recognize, that your salaries are paid out of tuition. And if we are not doing a good job teaching, if we cannot-- in our current vernacular-- provide a value proposition that is better

than that they have at the University of Buffalo, then we failed and it will come to haunt us in the long term.

So it's part of that-- and you mentioned these grants-- part of that, I decided, we-- should add that we built a new building. Our school was housed in a new building around 1990.

MARK EISNER: Rhodes Hall.

JACK MUCKSTADT: Rhodes Hall. And I decided at that time that we were going to make major investments in computing facilities for instruction.

MARK EISNER: Which was novel in those days.

JACK MUCKSTADT: It was quite novel. And as far as I could tell for at least more than a decade that we were the only department or school of an industrial engineering operations research type that actually had the computing laboratories owned and managed by the school, which meant that we could use them when we wanted to and organized all of our software and everything--

MARK EISNER: These were personal computers, what are now called ...

JACK MUCKSTADT: Yeah, these were personal - they were all PCs. And we got very good support from IBM. I mean, IBM was really the impetus ....

MARK EISNER: So in addition to hiring and finance during your time as director, you also impacted the way teaching was--

JACK MUCKSTADT: Well, I think, in terms of the long term, that was at least as important as the faculty, which changed also the way we were taught. So my view of life is, don't tell people what to do. Go do it yourself. Let them see. And then they will either accept it or not.

So again, with the support of IBM and a couple of other companies, we developed teaching tools that profoundly changed the way we were taught the subjects that I mentioned before-- the Design of Manufacturing Systems, Supply Chain.

MARK EISNER: They were called Nova and Llenroc.

JACK MUCKSTADT: Yeah, and all of these things here, there were probably five or six different, maybe a dozen different cases, with the word in them, Cornell spelled backwards.

MARK EISNER: And these are these are simulated manufacturing environments?

JACK MUCKSTADT: Yeah, and they're all based on some real case. So Plastics is a company that makes a Formica-like product. And so we have a case about how to design... And all these were consulting jobs that I had, that I turned into cases. And I extracted data and made up some data. But basically, so you can get the essence of the real environment.

So the students had to learn that life is not like a textbook. There are no problems that are related to the material you just read. There are just problems.

MARK EISNER: And you don't find the solutions in the back of the book.

JACK MUCKSTADT: And you don't find the solution. That's right. So you have to grapple with this. And necessarily no solution, a single one. So you have to grapple with these things. And that was what all of these-- so we called this experiential learning. And then there's a lot of people who now use that term.

But the idea was to give you experiences in what we called micro worlds, which is a way in which we compress time, space, and the collection of decisions that you make so that you can see the essence of the problems that you have and why approaching something in a certain way has benefits over another way. So you have simulated worlds that you work in. So this kind of technology has evolved over time, and I think we have it pretty well in hand at this point.

MARK EISNER: Well, some people would see that you've taught, you've done research, and you've done consulting as though they were separate things.

JACK MUCKSTADT: Oh, no. They were definitely-- but you can see. I mean, the consulting effected my teaching. I mean, I could never have taught any of these courses. The inventory theory one I could have because it's more of just theory. But the other courses-- and Peter Jackson was my colleague too. And so we taught these classes together because the way they were taught was not the normal way you teach an hour. (I taught the optimization classes, too, when I first came here).

You spend time one on one with students. So if you've got 70 students in a class, one instructor isn't going to be able to handle all of them. So you had two instructors all the time. And teaching assistants were not as helpful until they were the teaching assistant for the third year. And then they could--

MARK EISNER: You had trained them by that--

JACK MUCKSTADT: Yeah, trained them. They're smart.

MARK EISNER: I've observed your teaching style.

JACK MUCKSTADT: So there's one other thing that I want to mention, too, about what happened when I was a director. So we have a colleague-- a really good guy David Heath, unfortunately who died far too young. David came to me one day and said, we need to have a Financial Engineering program. I said, OK, tell me what you want to do. So he told me what he wanted to do, and following my time-tested model, I find what alums work in the finance business. So I find one that works at Merrill Lynch, a very, very strong Cornell supporter, call him, we go down there, and we get a lot of money from them. And so we had the first financial engineering program certainly in any engineering college -- I'm not sure -- it might have been in any other place.

And for the next several years, I got calls from all over, how did you go about doing this, and mostly from math departments, which was kind of interesting, because they finally figured out there's this way we can actually attract students to mathematics. But that was there was another important one. And because now we have a Master of Engineering program. There's about 100 students in it. And I think that's probably 60% of them are studying financial engineering. So none of that would've happened if it hadn't been for David Heath knocking on my door asking me that this thing started.

He was very energetic, and he worked with Bob Jarrow in the business school and Tom Santner. Those were good. Those guys were all very talented and worked hard to make the program - get it off the ground. And now it's a big deal.

MARK EISNER: So we're up to the '90s now, but I wonder whether in getting there are things that you wanted to talk about.

JACK MUCKSTADT: So let's just integrate the things that you mentioned. So you've got teaching. You've got consulting. You have the Air Force stuff, project RAND. All of these things, they just kept working together. When I joined the faculty in '74 there was another colleague. Dennis Severance was there. Dennis had been an army officer. So he and Tom Santner was an army officer as well.

And so with the three of us, we bonded in a way because of our military experience and similar

interests.

So Dennis left Cornell. And I was on sabbatical in 1987 at the University of Michigan. And I became reacquainted with Dennis again in a more serious way, we had kept in contact, but more serious way.

And that turned out to have some impact a couple of years later when Dennis was asked by the president of Aeroquip company.

MARK EISNER: Aeroquip?

JACK MUCKSTADT: Aeroquip, which is of one of the companies that belonged to Trinova. And they had this company that made this plastic. So I mentioned earlier that we had this Llenroc Plastics case. So they were having some manufacturing problems. I said they should call me. And so he did. And so I went off to this factory, and I began to realize that there-- well, actually before I got to the factory, they said, well, we have a problem in our warehouses. We don't have enough inventory. And it didn't seem to do any good to have more inventory because we still are only getting fill rates of around 2/3.

MARK EISNER: Can't make a lot of money that way.

JACK MUCKSTADT: Yeah. So tell us how much inventory we really need. So I looked at it. I mean, the whole thing was just-- I said, the problem's not that. The problem is in your plant and in your manufacturing plants. So they had just purchased another company to try to increase their manufacturing capacity.

So I sat around and watched. Now again the important thing to do as a consultant is not tell people the answers. It's help them understand their problem. That's the most important thing you can do. You can't solve a problem until everybody agrees what the problem is. So you may know what it is. Or you may think you know what it is. But that isn't going to help.

So I sat around with the guys who were running the company. And we went in and we'd sit and look. And I said, well, what do you see. And they tell me. And I said, well, really, it's interesting. But here's what I see. And then they start saying, oh, yeah that's interesting. That's a different point of view. Oh, that's interesting.

So to make a long story short, we made some very small cost investments and increased the capacity in their original plant to the point where they could sell the other plant they had

purchased. So at this time, I got a very interesting idea. So this was the late 1980s. Yeah, it was 1989. We're not quite into the '90s yet.

But this experience-- I started thinking about how this company was producing things. They were using a traditional MRP system to determine-- reorder points, reorder quantity kinds of rules to generate what you should be producing next. And it produced inconsistencies in the way that capacity was being used.

So I started thinking about items in terms of geometric shapes. So this stuff was made in lengths and widths. And the constructions, of them was a little different depending on the papers that were used. But the important point of this was that, instead of thinking about specific part numbers, I now created a schedule in which they had sizes. And if they had low usage parts and they had demand for it, they put it into their production schedule.

And instead of having huge amounts of finished goods inventory, we just reduced the number of items down. And I ended up calling this -- which I was just writing in a book today-- that "no BC" strategy means that the low volume higher variation products, don't stock them, make them. Now ultimately what they ended up doing was closing most of their warehouses because now you could make what you want and deliver it to the customer in less time than they were getting it from their warehouses to the customer.

MARK EISNER: So the original problem was they didn't have enough in their warehouses. And then it turned out you figured out a way they didn't need to have warehouses.

JACK MUCKSTADT: Not as many.

MARK EISNER: Not as many.

JACK MUCKSTADT: But the point is, you have to understand the problem. And in too much of operations, the researcher's accepting somebody's definition of a problem. And now you're going to go find some elegant way of solving this problem. So that said--

MARK EISNER: What was Dennis--

JACK MUCKSTADT: So anyway, Dennis Severance-- the point here is Dennis Severance introduced me to this. And then we developed this case, this Llenroc Plastics case. And I had worked with a student, Winston Pao, to get data together to create the case. Now, the interesting thing is Winston

Pao's daughter was a student in our school, is going to work with me this summer on a project with the local hospital.

MARK EISNER: I think if we did a network diagram of Jack Muckstadt's contacts, students, people you've contracted with, it would be a remarkable thing to study.

JACK MUCKSTADT: Yeah, it would. Anyway, so I got to work with Dennis. And the person who was the head of the Aeroquip corporation, they also had lots of other kinds of plants. And so he said, well, that was pretty successful. So he called me one day and he says, we make hose and fittings. And I've just looked at the financials. And we have something like 192 days worth of inventory in our system.

After what you did with the Llenroc Plastics things, we probably could bring that down. So I said, OK, well-- so what did we do of course? I said, let's go around and look. So we had a company airplane, went around the world, looked at their various manufacturing plants. And I came back. And they said, well, what should we do. I said, well-- he says, do we have too much inventory. I said, no, you don't have enough.

I could see at this point he was wondering whether he should just throw me out the airplane. So I said to him, you didn't ask me why I said that. He said, well, OK, why did you say. I said, because your manufacturing processes are all screwed up. I mean, this isn't going to work you. It's just the same problem we had in the other place. You just don't--

So an important lesson came out of this. So this was now 1990 or 1991. And one of the little phrases that I've developed-- I've got 8,000 of these little phrases -- But one of the things I told him was that we're going to have to change the people or you're going to have to change the people, which means that either we're going to get them to think about things differently or you're going to have to get different people.

And this turned out to be more of a challenge than I had thought. Now mind you, these plants were around the world. So there were a lot of different people.

MARK EISNER: Different nationalities.

JACK MUCKSTADT: Different nationalities. So Dennis Severance and I put together a collection of courses that we were going to teach all the management people in the company, thousands of people-- how to think about what they were doing. So we started off with what I would call manufacturing 101--

very simple ideas, taking some of the things that they did, putting them in context, trying to get them to think about things a little differently.

And then ultimately there were three courses we taught to thousands of people. So Dennis and I worked together on this for a long time. And to get all their plants in line, it took almost a decade.

MARK EISNER: And all this while, you're director of the school?

JACK MUCKSTADT: Through half of that time, I was the director of the school. But we taught these courses during breaks and during the summers and stuff.

MARK EISNER: The amount of energy you have in order to be able write more than 100 papers and ....

JACK MUCKSTADT: Yeah, but all of this material that we used for these courses has all been infused into our curriculum here. So the companies were willing to give us the rights to use all of these.

MARK EISNER: And the data?

JACK MUCKSTADT: And the data. So this turned out to be extremely important from an educational perspective. Now at the same time, interestingly, I was working with General Motors. And General Motors, like Xerox, had a bunch of warehouses and they had lots of parts. At the time, there were about 550,000 different parts that could be-- types that could be shipped to dealers.

But dealers carried in some cases very little inventory, in some cases, the biggest dealers, 10,000 part numbers or something on that order. And the system was just chaotic. So for about five years, from about 1995 to 2000, Dennis and I worked with General Motors on changing the system.

And then after that, Peter Jackson and I worked with General Motors on projects for Master of Engineering students. But one of the interesting experiences I had for a good part of the time I was working with General Motors-- the job I had was to check the work of the big consulting companies to see if it was right.

That was a very interesting experience. And most often, it made sense. But some of it was really sloppy. And most of the sloppiness came about because of what I would call the dogma of the times-- Just In Time manufacturing. There was one interesting day I recall-- the president of the UAW was in the room, and we were talking about-- the guy from this

consulting company, who'll remain nameless now, was pontificating about how they wanted to change the way GM was doing things to be more Just In Time.

So for example, you might have a part that was worth a penny. And they had lots of parts that were worth a penny on a shelf. And you're going to send the UAW worker, who is making with overhead $50 bucks an hour or $60 an hour, wandering off in a very big warehouse to get this penny part. And so I asked the present of the UAW-- I said, does this make sense to you that you would go do that.

And he just laughed. He said, of course not. So the guy from the consulting company nearly as clearly as ... I said, but... one of my other little phrases is that any good idea taken to an extreme becomes a bad idea. And so those are the kinds of things you would see. You'd see that there were certain ideas which were good ideas, and then they would try to apply them in situations for which they didn't make sense.

So the problem with a lot of analysis that's done, if you just try to replicate what somebody else has done without any thought, you're not necessarily going to come up with a product that has the characteristics that you find desirable. So - go ahead.

MARK EISNER: I was just say, one area we haven't touched on is your involvement with health care.

JACK MUCKSTADT: Haven't gotten there yet, because that's after 2000. Yeah, so these things all went on up to around the year 2000. And at around 2000, of course, they had what was called the dot.com bubble. So a lot of things happened in industries. Companies got bought. Companies got sold. So Aeroquip, for example, got sold to Eaton.

And so after a couple more years, I sort of-- because all the guys that I worked with, they all left. And so I stopped doing work with them. And basically at that time, I was over 60 years old and a few years before had gotten this notice from US Airways-- it was called US Airways at the time that I was one of the top frequent flyers in central New York. So I figured it's probably a good idea that I stop doing this stuff.

So about that time, partially due to this discovery that you had made, that the office in New York City that the Theory Center was running was-- well, the activity in it was going to stop because the person who headed it off, Tom Coleman, was going back to Canada. So now we have this facility there, and we had this Financial Engineering program.

So I said, maybe this would be a good idea. So you kept prodding me. And so I, again,

volunteered to be the head of this office in New York City, which I did for several years. But during that time, I had to figure out how I was going to meet the payroll.

MARK EISNER: In New York.

JACK MUCKSTADT: In New York, yeah. So I had this fellow working with me, Roger Lang, and Roger could find gold under any rock. So he somehow got in contact with the Medical College. And on the faculty there was a doctor, Nathaniel Hupert, And so Nathaniel-- sorry, I'd forgotten what year this was. But just early in the 2000s.

MARK EISNER: This is long after you had stepped down as director.

JACK MUCKSTADT: Oh, yeah. I was down as director about in 1996, something like that.

MARK EISNER: So this work is all in the school's interest, with your own portfolio.

JACK MUCKSTADT: Yeah, with calling me a Company Man in some sense. I believed that doing right by the entity is also doing well for yourself. So Nathaniel, it turns out that he had some contracts with a variety places, some with the City of New York. One was with the Clinton Foundation. So I'll come back to that in a second.

So anyway, this was an important source of money that we were now going to bring in so we could pay people's salary and we could keep the business, if you will, afloat until the financial engineering educational program could be brought up to speed and have a component of the education in New York City, which it ultimately now does.

So back to Nathaniel, so we have this contract-- or he has this contract with the Clinton Foundation for looking at the way treatment is provided to HIV-infected people in sub-Saharan Africa. Although I violated one of my principles. I didn't actually go there, I did send a team of people to sub-Saharan Africa. And they went in the various countries and see how this all was working.

So it was very enlightening in the sense that the infrastructure in these countries was not up to-- ... as you'll probably recall, major gifts were made by Bill Gates and his wife and others who were in the pharmaceutical companies. And the logistics system, is, or was, inadequate to get stuff to people. I mean, they would do blood tests for people to see what the progression was. And they would get the materials in some town. And then they would bounce along in a

Jeep to a laboratory.

And apparently the bouncing around messes up the ability to ascertain actually what was in the blood. So I mean, just so many things were just done poorly. The doctors in the big cities were not compensated properly. So they wouldn't see the patients. I mean, the whole thing was just-- so even when you get you down to the fundamentals of trying to understand how you run something like this.

And you recognize that you must understand the environment before you try to provide a solution. Now the Clinton Foundation had an operations research group. But unfortunately, it had nobody in the group that had a degree in operations research. And it wasn't exactly like the RAND Corporation. So Nathaniel and I felt that we could no longer provide any value to the that. So we kind of dropped out.

But at the same time-- or roughly, the same time -- now we're into the latter half of the 2000s, I get a letter from the Secretary of Health and Human Services, asking me if I would like to be on the board of scientific counselors, as they call it, the CDC. So I did that for five years. And that was a lot of fun.

And during that period of time, the 2009 disaster occurred for the influenza pandemic. And so I got to look at how the CDC operates. Now the CDC does a lot of very good things. I mean, there are lots of very skilled people. Almost everybody you run into there has either an MD degree or a PhD in pharmacology or something. So they're very skilled people.

But one of the things that they were tasked with doing was running a warehouse system and being able to deploy the elements of the things they stored, medicals stockpiles, during an emergency. Now while they maintained these warehouses very nicely, one of my other rules is that organizations and individuals cannot perform complex tasks efficiently or effectively unless they do them all the time.

And that's not what the CDC did. Now what it does all the time it does extremely well. But this kind of activity is not-- and it never should have been assigned this task by the Congress. I mean, so it's Congress' fault. So it didn't go as well as it might have. So I worked for a couple of years trying to figure out how to do this better and convince them of what they should do differently.

And so if you just go back to the phrase, who delivers things every day to every hospital in the

United States? So there's a few companies, like Cardinal Health, that do this every day. So you'd really need to work into an infrastructure that exists in order to make it work well. So I could talk two hours about that problem. But nonetheless, it was it was another interesting activity and, again, it came down to-- the question is, understand how this system works, understand what attributes it needs to have, understand what players have the attributes that are needed to be able to pull this thing off in a way, and also try to find a way to save the taxpayers' money and also be more responsive.

So that was an interesting thing. And one of the students here who worked on with me, Christine Barnett, she got interested in this health care. And then she and several other students, all women students, I might add, they all went out to get PhDs someplace related to health care.

MARK EISNER: That's part of your legacy.

JACK MUCKSTADT: That's right. But I mean, all this stuff is about trying to do the right thing and trying to involve students in things that will expand their set of interests and give them the opportunity to work in areas that clearly need assistance of people who have the kind of skills that they have. So I think that's important.

And when you look back over time, I've written a number of papers. Some of them are very good. Some of them are just OK. But the lasting impact that we have, virtually every faculty member, is the students that you teach.

MARK EISNER: Indeed. So you became emeritus. What year would that have been?

JACK MUCKSTADT: I have no idea.

MARK EISNER: Well, we had a big party.

JACK MUCKSTADT: Yeah, so I guess it was around 2014 or something like that.

MARK EISNER: But you are still teaching actively.

JACK MUCKSTADT: Yeah, that's right. So this health care stuff has continued, and I've worked with the Cornell Hospital in New York and the Hospital for Special Surgery in New York. And the local hospital--

MARK EISNER: Masters projects--

JACK MUCKSTADT: Yeah, and projects but also giving them advice on things. So those experiences have been, I think, very good. And we're just in the end the beginnings of working here with our local hospital in ways of-- let's see-- trying to understand the massive data sets that they now have. The person who is who runs their data warehouse, if you want to call it that, is one of our former MEng students. So there's lots of opportunities for understanding what the data are telling you.

MARK EISNER: It's interesting that you pretty much haven't mentioned data until now, and yet you did all this effective work in these companies when it was a time of, not only computing immaturity, but data immaturity.

JACK MUCKSTADT: Yeah, well, so I was always careful to choose projects where I could get the data. General Motors one was really interesting, because General Motors on its board of directors had a person who had run for president of the United States.

MARK EISNER: Heard of him.

JACK MUCKSTADT: And so Perot Systems eventually began to do all the analysis and data storage for General Motors.

MARK EISNER: That was EDS I guess.

JACK MUCKSTADT: Yeah, and it turned out that the service parts operation of General Motors no longer had any analytic talent. It was all absorbed into Perot's company. So Peter Jackson and I would get the weekly reports of all the transactions that occurred, and we would report back to them what happened. It was really quite a humorous situation.

MARK EISNER: From Ithaca, New York.

JACK MUCKSTADT: From Ithaca, New York. That's right. And we'd have these meetings. Peter would go out much more than I would. And these meetings were always hilarious. You'd get this large group of people, and Peter-- we didn't know what we were-- we would just be sorting through the data. And people would get up, and they'd start screaming about what the dealers were doing and why didn't we do that. It was really hilarious.

But you're right. But I was always careful, always careful, only take things where either I had

the data or I knew I could get the data.

MARK EISNER: So we brought things up more or less to the present. You're emeritus, but you're still very actively involved. You've moved to some extent into the health care field, but I'm sure some of these other interests--

JACK MUCKSTADT: Well, that's been my primary interest. Now of course, working with students has always been I think the thing that makes me happiest. And I'd like to see them go out in the world. I keep in contact with lots of the former students. And it's always enjoyable to hear about what they're doing. And they like to share their stories with me.

MARK EISNER: We saw a lot of that at the party in New York, this fabulous affair honoring your retirement when a number of the students both there and in a separate party here in Ithaca.

JACK MUCKSTADT: Yeah, they were wonderful events. I was happy that my grandchildren, some of them, could come and see that. That was very nice of the school, went out of its way to be kind to me.

MARK EISNER: Now when you started out, it was really at the very beginnings-- I mean, started after World War II, but in the early '60s, from an academic perspective, was when the field really began to take off. Now we're talking 60 years later. What would you tell a student today to get them interested?

JACK MUCKSTADT: Well, let's do the reminiscing. The 60 years ago, lots of the basic models that we thought about could anywhere come close to being applied in any practical situation. In fact, I did what I did with the Air Force was, that was a fluke in the sense that it was a closed system. It could deal with it because they had data systems in place to collect data and do the things you had to do.

But for the most part, for what I would call really large scale problems, computing speeds weren't there. The data weren't there. You couldn't get the data in time. Well, look, I was working with a company in Europe. And this was in the late 1980s. And if you wanted to send something electronically, data electronically, from Germany to England, you had to go through the Bundespost and you had to pay enormous fees for transmitting the data. So you put the data on floppy disks and your real time was whatever the speed of the postal service was to get it to England.

I mean, it wasn't just technology. It was also governmental nonsense that got in the way of being able to do things. So all that's changed of course. So it's certainly true we've made

algorithmic advances and quite substantial ones. But the real difference is the cost of computing and the cost of data storage and the cost of acquiring data, all that stuff.

But still fundamentally, unless the data are clean, they're accurate, they're measuring things properly, you can't do anything with the algorithms. That's just hopeless. So it all comes down to acquiring and making sure the data are right. I mean, health care stuff-- so you look at health care records. And you'll look at a procedure. And one doctor has entered it a certain way, the words about it. It's exactly the same procedure, maybe even by the same surgeon. And the next time it'll be recorded slightly differently. So just getting a dictionary to try to figure out what all this means is an enormous task.

So all this stuff, it's so obvious, but it's what stops things from getting done. So the places where there really are data-- and hospitals do have lots of interesting data. So these are these are things where you can actually do something because you do have the data. So when I go to the Cornell Hospital, I can show them exactly every patient how it flowed through the hospital because we have all the stamps when they go through.

Now they may not be actually perfect, but you can watch the flows of people. And you can see the results of policies that the hospital has and why people get jammed up in various places.

And they're dynamic. There's no steady state analysis in any of this. So the mathematics sometimes isn't there. But you can easily point to what you ought to do. And then you can see what you can do to fix it.

MARK EISNER: So you're suggesting that this all creates new opportunities for students.

JACK MUCKSTADT: It does. But it still comes down to the importance of quality data. And just saying that you have vast amounts of data and now we can do machine learning or whatever in its own right is not going to get to where you want. I mean, obviously, the big accomplishments-- I didn't mention anything about the work I've done with Amazon.

But I think one of the important things in Amazon does is they understand the imperative of quality data. Otherwise, transactions are not going to work the way they want.

MARK EISNER: And they have a huge amount of it.

JACK MUCKSTADT: Yeah, that's right. That's right. And companies like Uber where you have huge numbers of transactions that occur. And they're all very simple transactions. But now you can do all kinds of analysis on these data.

MARK EISNER: So you see lots of opportunities.

JACK MUCKSTADT: Oh, sure.

MARK EISNER: I mean, I'm getting back to the question of, how would you persuade somebody or suggest to somebody that this is the right field to be in.

JACK MUCKSTADT: So I persuaded my grandson to go into this. And I just told him that this field gives you the opportunity to do more diverse things than probably any other profession. And so I started out in mathematics. I really have not done much with mathematics in my professional life. I'm talking about the "outside of Cornell" life.

I mean, it's more just thinking about how systems work, applying the scientific method, create your hypotheses about something, test them, revise them, and then hone them. And then once you have something that you think works-- now, all that time while you're doing that, you're talking to a lot of people.

MARK EISNER: Talking and listening.

JACK MUCKSTADT: Listening is more important than talking. When I was in the Air Fprce, there was a person who said to me, you can't learn anything when your mouth is open. So it's important to listen and learn by listening and being humble about the whole thing. We're all smart, but we all know virtually nothing.

MARK EISNER: I can pick out strands of what we've discussed here that would answer this question that I'm about to ask. But I want to ask the question anyway. And that is, how would you most like to be remembered 20, 30 years from now.

JACK MUCKSTADT: Oh, well, that's easy to answer. I think you can summarize it in two words-- he cared.

MARK EISNER: Very good, very good. And I see that observing your day to day activities. You do care.

JACK Yeah, because it's important to remember-- going back to what I said earlier, I was very

MUCKSTADT: fortunate. It's very important to remember that certainly you make your own bed, so to speak. But the fact is, you've got to realize that most of your successes ultimately due to others giving you opportunities and nurturing you and helping you. It's the way it is.

MARK EISNER: And then paying it forward.

JACK MUCKSTADT: Yeah.

MARK EISNER: Jack, I want to thank you very much for sitting for this interview. It will go together with a collection so far of more than 40 interviews that we've done of this sort. I think this will be one of the most instructive to people who are entering the field and to people who are in it already.

JACK MUCKSTADT: Yeah, I appreciate the opportunity. Thank you.

MARK EISNER: Thank you.