VIJAY MEHROTRA: I'm Vijay Mehrotra, professor of business analytics and information systems at the University of San Francisco. And I have the pleasure and privilege of having a chance to interview my dissertation advisor, Professor Frederick S. Hillier of Stanford University. Fred, I want to take you back to your days in high school. If I think about that, kind of 1950 to 1954, what was it like in those post World War II days, and how did you get interested in so many different subjects?

FREDERICK HILLIER: Well, I grew up in Aberdeen, Washington which is pretty much on the coast of Western Washington. In fact, during the Second World War, to go back even further, there was speculation that the Japanese might come ashore right outside of Aberdeen on Grays Harbor. So the 1950s to '54, Aberdeen was a relatively small blue collar lumber town. And it was still going reasonably strong right at that point, but the lumber mills were starting to close down.

And in high school, I did get overly, heavily involved, particularly my senior year. I served as the student body vice president, arranging an assembly every week and inviting people to perform. And then, president of the Leadership Club and on the debate team and on the band and orchestra and a member of the baseball team, and a few other things. Involved in a math contest, in an essay contest, and so forth and oh, a member of the Grays Harbor Symphony Orchestra, and also gave music lessons. I had five flute students my senior year, and so on. Very busy time.

VIJAY MEHROTRA: I'm fascinated with the diversity of interests, and that's a theme that we're going to explore further in the interview. When it came time to look at colleges, I'm really curious as to how you'd ended up choosing Stanford.

FREDERICK HILLIER: Well, I feel that I've lived a really blessed life. There were a number of coincidences that came along that pulled me in the right direction, and one of them had to do with the final decision to go to Stanford. My dad was on the faculty at Grays Harbor College, then called Grays Harbor Junior College, and was in fact Dean of the Faculty at that point. And so I, like my two older brothers, the family assumed that I would go to Grays Harbor Junior College to start with and then just transfer up to the University of Washington.

And I was talking in terms of majoring in industrial engineering. And so that would have been the only college I would have applied to. But my senior year, our chemistry teacher happened to mention fairly early in the year that there was this really attractive scholarship being offered

at a number of colleges around the country, and the nearest one was Stanford. And so that finally, in my senior year, got me to thinking well, maybe I could look into this. And I did, and I got a very attractive scholarship. Two scholarships, actually.

And we worried about the fact that, would it look bad if I didn't go to my dad's college? But finally decided that that was OK, and so off to Stanford I went.

VIJAY MEHROTRA: I know that Jerry Lieberman was your original freshman advisor, assigned at random.

FREDERICK HILLIER: Yes. As I say, I have lived a charmed life. And that was so crucial to my career going forward. Of all the freshman advisors I could have had, I had Jerry Lieberman. And when I had my appointment to meet with him, I was a little nervous thinking that I would be meeting with an older, dour Stanford professor who would have no interest in me. And instead, there was this very outgoing, personable young man Jerry Lieberman, who seemed to take an interest in me right away.

We even talked about Stanford football and we ended up being sports fans together. We shared 49er tickets together many years later on. So Jerry was my freshman advisor. And if you want me to jump ahead, he later was my undergraduate advisor. And as my undergraduate advisor, he was very much my mentor. And then he became my graduate advisor and then my dissertation advisor and later my department chairman. And then a bit later, my textbook coauthor.

VIJAY MEHROTRA: I know from our conversations that Jerry's had a profound impact on your career trajectory. I'm intrigued about the decision to stay at Stanford for your PhD program as opposed to going somewhere else. Can you share a little bit about that?

FREDERICK HILLIER: Well, at that point, operations research was a very new field. Not a completely new field, since it has roots going back to 1532 I think from a book over here. But the field primarily got under way through teams of scientists in the Second World War. And we're talking about just a decade or so after that, so it was a very new field. So you were asking about?

VIJAY MEHROTRA: Your decision to stay for graduate studies at Stanford?

FREDERICK HILLIER: I was blessed by the fact, another blessing, that Stanford had a number of faculty who were early pioneers in the field of operations research. People like Ken Arrow and Herb Scarf and

Sam Karlin who were involved with developing the s-S policy for inventor theory and things like that, and several other top people who were getting involved with this new field. And within the industrial engineering department, Jerry Lieberman and Harvey Wagner were two outstanding people who were beginning to develop a particularly strong graduate program. And so with all of these resources at Stanford, again with Jerry Lieberman's encouragement, well of course I should stay on to take advantage of this opportunity.

VIJAY MEHROTRA: Jerry had kind of a big vision for what operations research might become and what it might become at Stanford. Can you share some of your early conversations about that with Jerry?

FREDERICK HILLIER: Well, at that time, a catchphrase around the university was to achieve a pinnacle of excellence. And with all of the resources that I've been describing to really build up this new graduate program in operations research, it was felt that Stanford had the opportunity to have this program become a pinnacle of excellence, to really perhaps lead the way nationally and internationally in showing what graduate education in operations research should be and should become.

VIJAY MEHROTRA: That's terrific, which brings us to your dissertation. Can you tell me kind of what your topic was and how you came about focusing on that problem?

FREDERICK HILLIER: Well, my degrees were in industrial engineering. At that point, there was not a degree available in operations research per se. But after taking my first course in operations research as a junior from Jerry Lieberman, that really captured my attention and I knew that I wanted to go into this exciting new field. I was involved with a number of different areas in my early research and later on, was in quite a few different areas.

But Jerry was guiding me as my advisor and I ended up taking 17 courses in statistics. And Jerry was a leader in the statistical quality control area and actually won a big award, the Shewhart Award for his accomplishments in that area. So in addition to OR per se, I was also taking courses and looking into research in the quality control area.

And so one day, I was sitting in church and not concentrating enough on what was happening in the church service. I was thinking about this particular kind of sampling plan, a continuous sampling plan, and a shortcoming in terms of how you should be choosing the best continuous sampling plan. And the idea popped into my head, well, of course it would make a lot of sense to add on these new criteria. And so I took this to Jerry and he encouraged me. OK, that

sounds like a good direction to go for your dissertation topic.

VIJAY MEHROTRA: Great. And so, you finished up at Stanford in 1959? 1958?

FREDERICK HILLIER: Well, I started as an undergraduate in '54 so I didn't make it in five years.

VIJAY MEHROTRA: But not much longer.

FREDERICK HILLIER: '61.

VIJAY MEHROTRA: And at that time, with the growth of the field and your pedigrees from Stanford, there were probably a lot of different opportunities.

FREDERICK HILLIER: Well, once again, Jerry was promoting me around the country. And so I had offers from quite a few other universities along with a very nice offer from Stanford. And since I had been at Stanford for both undergraduate and graduate work, I really had the feeling that it would be good to go elsewhere for at least a little while and maybe return to Stanford. And so I did my interviewing and after interviewing at Carnegie Mellon and then at Yale on one trip, I concluded OK, I think I'll accept the offer at Carnegie Mellon in their Graduate school of Industrial Administration.

And then I took a bus from New Haven to New York to catch my airplane trip home, and it started to snow. And it snowed heavier and heavier and heavier. This ended up being the worst snowstorm blizzard really in 13 years in New York City. And so I got to the airport and my flight had been delayed not because of the snow, but because of a mechanical difficulty for 50 minutes. And that again was a crucial 50 minutes, because then we boarded the plane, went out to the hangar, de-iced the wings, and because of that 50 minute delay, the airport had just closed down.

Well, there I was stranded with all my luggage and so forth. I had to somehow find a place to stay. But Jerry Lieberman, once again, was on sabbatical leave at Columbia University. And so I called him and he invited me to come stay with him and his family. He was in Queens. And I had a difficult time finding a taxi driver who would give me a ride because they knew that their trip with their customers would be the last trip of the night because of the blizzard, and they

were only taking people to Manhattan. Well finally, I was able to get a taxi driver to agree to take this family to Manhattan and drop me off on the way in Queens.

And so he dropped me off at this intersection, not at Jerry's apartment, and pointed, it's that way. And so in this snowstorm, carrying all my luggage, he had pointed in the wrong direction. And so I was drudging through the snow and trying to find this apartment and wondering whether I was going to make it, actually. An hour later, I got to Jerry's apartment.

Well, the airport was closed down and not only that night, but the next day. And not only that day, but the following day. And not only that, the following day for a while. So it was three full days. And so what did Jerry Lieberman do during those three days? Talked to me and talked to me and talked to me about no, no, no, you should really stay at Stanford. And Jerry's advice had always worked out very well for me. I chose to stay at Stanford.

VIJAY MEHROTRA: The research on quality control and sampling really definitely reflects some of Jerry's influence, but I think there are a number of ideas there. Can you just tell us a little bit about some of those projects?

FREDERICK HILLIER: Well, because of my dissertation and interest in quality control and statistics and probability theory in general, I continued doing some research in that area along with a variety of other areas. And so there were a number of papers, this is 50 years ago and I'm having trouble remembering the specific topics. But there were several. One or two involved designing a control chart limits. Another involved surveillance of materials in storage from a statistical viewpoint. And of course, published my dissertation and so forth. But I was going in really several directions at that point.

VIJAY MEHROTRA: And from looking at the titles of some of your early papers in applying queueing theory to production systems, I get the idea that this was very innovative at that time.

FREDERICK HILLIER: Well, queuing theory really appealed to me. I was very interested in the area, and partially because it had so many applications. I was drawn both to topics that had some interesting mathematics, perhaps elegant mathematics. But at the same time, drawn to it also having important applications.

And one particular application of queuing theory in the production area or operations management area involved if you have an assembly line or a production line where the assembly times or operation times were variable, should you really strive to have a balanced

line or could you actually increase the throughput by purposely unbalancing the line in a certain way? And so what I and my co-author discovered was that yes, if you plot the optimal allocation of work to the workers on the assembly line, at station one, at station two, and so forth, that it had the shape of a bowl. So less work assigned to the center stations, and that would give you an improvement over a perfectly balanced line. And that was one of my topics of research in the 1960s. And then I came back to it in the late '80s and 1990s. And in fact, our son Mark Hillier and, I've forgotten the date, but about 10 years ago or so--

MARK HILLIER: 2006, I think.

FREDERICK HILLIER: Our son Mark who's sitting in listening to us, he and I have a paper in this area. And so I was extending this concept in a variety of ways. And I was gratified by the fact that researchers in the applied probability area had picked up this theme and were developing some theoretical results that were helping to establish that indeed, the bowl phenomenon was indeed a relatively general correct concept.

VIJAY MEHROTRA: I certainly remember those papers, as well. The irony of having a coauthor named Boling working on papers with the bowl phenomenon is a favorite of mine. But I think overall, probably your most celebrated research paper appears to be "The Derivation of Probabilistic Information for the Evaluation of Risky Projects." It's been cited by over 400 researchers and reprinted in a bunch of different publications in a bunch of different languages. Can you talk a little bit about the motivation for that work and what kinds of things it ultimately led you to?

FREDERICK HILLIER: Well, to back up as to where this started, as a graduate student, again with Jerry's blessing and suggestion, I taught two courses as a graduate student. And one was a course called Engineering Economy. And I had also been taking some economics courses.

And whenever I was involved with some area like economics or engineering economy in this case, I would in the back of my mind be thinking about why isn't this particular direction fleshed out? What needs to be done in that area? And so in particular in this case, I felt that it was important to be able to analyze the risk involved when dealing with individual investments or interrelated investments. And so this paper published I think in 1963 might have been my first publication. I'm not sure.

VIJAY MEHROTRA: It was surely among them, yes.

FREDERICK HILLIER: It was a paper on risk analysis. And it turned out that I think that was perhaps the first such paper to my knowledge, and then risk analysis became more and more important over the following years. And actually, this paper led to a research monograph that I published.

Let me back up. There was a research contest involved that I found out about in late 1962 or early 1963, sponsored by the Institute of Management Sciences and the Office of Naval Research on capital budgeting of interrelated projects. And so I thought OK, well let's continue the research in this paper and let's focus on the analysis of risky interrelated investments. And I developed this paper that I submitted to the competition and it won the prize. And they invited me to develop it a little further and publish it as a research monograph, which I did.

VIJAY MEHROTRA: And that really, again, is something that's been clearly very influential, I think if there's one thing that you're probably best known for even beyond that paper, it's the "Introduction to Operations Research" textbook. I'm really interested, particularly as we've been talking about your early research interests and how diverse they were, that in a way that reflects kind of where the field was in those days, when there was a lot of different work on a lot of different areas. How did you and Jerry come to the idea of writing a kind of foundational book like this?

FREDERICK HILLIER: Well, I mentioned that I as a graduate student, taught two courses. The other course I taught was called Introduction to Operations Research. And because of my great interest in operations research, I took this on as a real challenge to try to develop a master course in operations research to the best of my ability. And so I worked very hard on the course, developed rather extensive lecture notes, and so forth. Taught the course. It went very well. But we didn't have any particularly good textbook to use in the course.

VIJAY MEHROTRA: Were you using predominantly notes?

FREDERICK HILLIER: Yes. I'm trying to remember whether I actually used any textbook. When I took the undergraduate course, there was one slender book by Sasieni, Yaspan, and Friedman. It's possible I used that, but it was based primarily on my lecture notes. And so then, this was in the spring of 1961.

That summer after I had gotten my PhD, Jerry and I started doing a lot of talking. This course had gone very well. Jerry had done an outstanding job in teaching the same course, when he did teach it. The field really desperately needs a good textbook, so why don't we write it? And so that was just within a month or two after my PhD.

And so we were talking about that and thought that was a very good idea. Jerry was a well known author at that point but he wanted me to be an equal co-author and have my name go first, because alphabetically it would. And so I was delighted to partner once again with Jerry Lieberman to do this. Because I had been a student throughout at Stanford, everyone involved agreed that it would be a good idea for me to see a little bit of the rest of the world. And so it was arranged that after one year on the faculty, that I would go on leave somewhere else.

And so I went off to Cornell for the year. They were developing a good program in operations research. It was a very good year. And so Jerry and I agreed that OK, let's do the book. He had some contacts with publishers, but let's wait 'til I get back from that leave. And so we didn't launch in until June of 1963.

VIJAY MEHROTRA: How long did it take and what was hard about it?

FREDERICK HILLIER: Well, it was eventually published in 1967, but there were a lot of other things going on in our lives. A lot of research that I was getting done, had this research monograph to deal with, and so forth. But the first summer that I got back from Cornell, because I had been on leave, I didn't have any PhD students to deal with, I was not on any committees, I could just focus on writing at least the initial chapters of this new textbook.

And so every day, at least Monday through Friday, I would go into the office. I'd get in at 8:30 to 9:00, be there continuously writing until 5:30 or 6:00 except for lunch, go home, review my materials to be able to launch into the next thing the next morning. And I just did that day after day after day. And that went on throughout the summer. And I was able to finish the first draft of four chapters. I had to be very disciplined. I set a goal that before I could quit working, I had to have at least 12 handwritten pages written. And so, I just kept after it day after day and that's what it takes to least launch a new book.

VIJAY MEHROTRA: Right and you had the road map to follow. And so what I'm wondering about is when the book came out, how was it received and what kind of responses did you get initially?

FREDERICK HILLIER: Well, I should first mention that we did test the book considerably at Stanford. We printed copies of the current drafts of the book, at least those that were done, and used that as our textbook in the courses that we were teaching. So we got a lot of good feedback and did some redrafting and so forth. And when the book was published, it was a really amazing response.

We really, or at least I, had not anticipated that this new textbook would take over the market, so to speak. Just a tremendous response.

VIJAY MEHROTRA: I think it's probably a great testament to the care and effort that you put into it that you got that kind of response and that kind of widespread adoption. Can you give us a sense of kind of how widespread that adoption's been and how many copies of that book are out there?

FREDERICK HILLIER: Well, as with another later textbook, I was gratified by not only the response within the United States by American college students, but by how the rest of the world was using the textbook. And I was told quite a few years ago, maybe 15 years ago, that there had been translations into 16 other languages of the "Introduction to Operations Research" textbook. And there probably have been a few more since then.

And so when you look at sales through the translations and then international student editions and then American college textbook sales and so forth, it's been something over half a million copies sold. And we didn't receive a record of the sales through a lot of the translations, so it's been quite a bit beyond that, I'm sure. And then with used book resales, my guess is that it's perhaps been used by somewhere in the neighborhood of a million students throughout the years. And I've been told by a lot of individuals that they became interested in going into the field of operations research because of that textbook.

VIJAY MEHROTRA: Yes, present company included, definitely. I want to come back around to the book in a couple of minutes, but there's a paper that you wrote with several Stanford colleagues calling for the creation of a systems optimization lab. Which in 1973, was a pretty radical idea. Can you talk a little bit about what was behind that and what was the motivation for that?

FREDERICK HILLIER: Well, Stanford, at least in our opinion, had been becoming the leading department of operations research in the country and perhaps the world. We had brought George Dantzig onto the faculty in 1966 and so forth. Outstanding faculty. But we also realized that in order for operations research to have its full impact, that it was important not only to be developing the theory of operations research, further developing the techniques of operations research, but also to be helping the field achieve its potential for applications - to do this it would be very important to develop leading software for implementing applications.

And so, that was the real impetus behind this idea of having a systems optimization lab. Let's bring in some leading top-notch people who perhaps had degrees in computer science but were also involved with operations research. And 40 years later, we still have Michael

Saunders who was part of that group and is still there, as is Walter Murray. We also had a couple other leading people who have gone on to other universities.

And they have done a great job over the years of developing this software that has been very widely used. Michael Saunders has been famous for his MINOS software and there have been many other software packages developed within that Systems Optimization Laboratory. And George Dantzig was also a leader in some energy modeling that was largely done, I think, through that laboratory.

VIJAY MEHROTRA: Through the SOL. I think that that's a really important point that that was a forward looking thing to propose in the early '70s, long before we had a software industry, and 20 years before the launch of the Netscape browser. To be thinking about that really speaks to the really long term view that you took. Any other specific memories of the Stanford OR department which really did seem to be a group of all stars that had come together in some way? And actually, maybe we could start with when did the group come together?

FREDERICK HILLIER: Well, some interesting history. I mentioned that when I was a student at Stanford, that there were a considerable number of faculty throughout the university who had become very interested in this new field of operations research and were doing some very interesting research in it. And so in 1962, under Jerry Lieberman's leadership, and now with some junior faculty involved, including myself and Pete Veinott had just arrived, and then let's bring in the senior leadership with some of the names that I mentioned earlier, we had all the resources we need now to have a program, an interdepartmental program, that would offer a PhD in operations research. So this interdepartmental program in operations research was founded in 1962 and we immediately attracted some outstanding students who've done some great things since then.

And so we're off to a great start. And it was felt that it was clear that we could stand on our own. so let's become a separate department. And so in 1967, we became a Department of Operations Research.

VIJAY MEHROTRA: So I chuckle. That's 20 years before I arrived.

[LAUGHTER]

What's interesting is that you also write during that time that you started to do a lot of work on integer programming, which seems kind of not a natural follow on to a lot of the topics you were working on earlier. How did your interest in integer programming come about? Was it-- I think of it in the context of the optimization lab and the department emerging.

FREDERICK HILLIER: Well, one big difference between operations research back then when I was starting in the field and operations research now is that the techniques that we take for granted now were just being developed back then. And you didn't need to become a super specialist in a certain area to really do path breaking research in that area. You could work on these basic techniques.

And integer programming, when I joined the faculty in 1961, what was available? Well, there was this Ralph Gomory algorithm that had attracted a lot of interest. Unfortunately, it didn't work very well from a computational viewpoint. There was another kind of approach called a branch and bound approach. There was a first paper in that area, I think, was 1960 and there were a couple others, but it wasn't well accepted yet. Obviously, integer programming would have numerous important applications.

So how do we develop algorithms that would enable us to really implement these applications? Well OK, that was a challenge that I felt that I wanted to take on. And I found the area quite intuitive, just dealing with lattices so forth. And so I launched into it and in addition to algorithms, I also developed some heuristic procedures for dealing with large integer programs. And I was gratified some years later to have Fred Glover, who became a leader in developing metaheuristics, Fred Glover thanked me because he said that I made it respectable to do research on heuristics.

VIJAY MEHROTRA: As I kind of think of different things that you've taken forward over a long period of time, I come back to "The Introduction to Operations Research" which is now in its 10th edition?

FREDERICK HILLIER: 10th edition, yes.

VIJAY MEHROTRA: I'd be interested in your perspective on how the book has evolved over the years and what a reader of the first edition might find to be startling in the 10th.

FREDERICK HILLIER: Well, I think I haven't gone through this exercise, but I think if you started looking at the first edition, you started looking at the 10th edition, you would think that they almost were two

different books. One difference was that the first edition was only 630-some pages with not a particularly large trim size. And then in the seventh edition, with a much larger trim size it had gotten up over 1,200 pages. I've managed to trim it back down to just over 1,000 pages now.

One reason for the growth of the size of the book is that I've emphasized having each new edition really keep up with new developments. And so there have been a few new topics going into each new edition that I felt were important developing areas that deserve attention at the introductory level. And then in terms of the expository approach, the first edition was a provided a pretty-- straightforward presentation. For each chapter, I would begin by summarizing the mathematical model involved. Well, I concluded that that wasn't the proper motivation. And so in the second edition, I made sure that at least almost every chapter would have what I refer to as a prototype example, almost a mini case, that would illustrate the kind of application of this area and provide real motivation for why a student should be interested in going into this. And so that was another important evolution.

VIJAY MEHROTRA: We're thrilled to have Mark Hillier join us. Mark is Professor Fred Hillier's son and he is also a professor of operations research and management science at the University of Washington. Fred, can you tell us a little bit about Mark's very, very first involvement with operations research?

FREDERICK HILLIER: Well, his very, very first involvement was that he was born almost a year before the first edition of the "Introduction to Operations Research" textbook was published. So he kept us up at night while we were trying to put the book to bed.

[LAUGHTER]

But then he got involved more directly some years later.

VIJAY MEHROTRA: Mark, I have known your family for many years and knowing that your brothers have pursued things other than operations research, I'm curious as to how you personally got involved and interested in the field.

MARK HILLIER: Well, you may be surprised to know that as a kid, I didn't even really know what operations research was. Just by being the son of Fred, I always heard him give his one sentence definition of, it uses mathematical models to aid in decision making, but that was really all that I knew about it. But in my undergraduate work, which I did at Swarthmore College, there was this course entitled Introduction to Operations Research and I felt like I had to take that course

to see what my dad did. That book used the fourth edition of the Hillier Lieberman text, and it was really through that book I fell in love with the topic and knew that's what I wanted to do.

VIJAY MEHROTRA: So it was right about that time, the fourth edition, that I first encountered the book. I was studying for an actuarial exam that included a section on operations research. And at that time, there was no software at all. So we would read the descriptions of the algorithms in the text and then we worked everything out by hand for our homework. Mark, can you tell me how you came to get involved with software development associated with the book?

MARK HILLIER: Sure. So I had done a little bit of computer programming. I had a computer science concentration at Swarthmore and I was approached by both Jerry and my dad because they wanted to include some tutorial software. Really, the idea of the software was to allow the students to focus on not the math, not the number crunching of the algorithms, but instead allow them to really focus on the concepts of the algorithm. So the software would allow them to interactively work through the algorithms without having to do the number crunching. And it became my senior engineering project at Swarthmore to develop that software.

VIJAY MEHROTRA: Very interesting. And we've talked a lot about Jerry Lieberman today, who's obviously a colleague and a mentor to Fred, a professor of mine as well. Although we don't have Jerry here with us today, Mark, can you tell us about your work with your father and Jerry on the "Introduction to Management Science" textbook, the Hillier, Hillier, and Lieberman textbook?

MARK HILLIER: Sure. So they had started in on this book project before I got involved in it, in the early '90s. And the field changed so much. How management science was taught was really changing through the '90s to be more of a spreadsheet based approach and getting away from the algebraic modeling. And they brought me in at that time. I was teaching some spreadsheet based courses at the Foster School of business at UW. And they brought me in as the spreadsheet guy. So it then became Hillier, Hillier, and Lieberman for the first edition and. I did basically all the spreadsheet work in the book.

VIJAY MEHROTRA: And so, I would think you probably had a fairly dramatic impact of that project, based on your background, the times when you were beginning your career, the tools you grew up with. Last question is to both of you. I looked back on a paper that you both wrote together a few years ago about the ways in which introductory management science and introductory to operations research are being taught now and how that's evolving. I'd like each of you to just say a little bit about that.

MARK HILLIER: I can speak about introduction to management science, which is what I teach at UW and really since the late 90s and early 2000s. So the transition has been away from, as I said I said a minute ago, the algebraic approach and towards using spreadsheets, because businesses live in spreadsheets. Students weren't interested in the math of it and were really turned off by the math of it. So a combination of speaking in their language through spreadsheets and not focusing so much on the algorithms, but really more on the business problems that can be solved and focusing on how can the models be used to help them solve the problems that they want to solve? And all of that I think changed quite a bit over the last 20 years.

VIJAY MEHROTRA: Fred, anything to add?

FREDERICK HILLIER: I should mention that the Mark has developed into a master teacher at University of Washington. He's one of two faculty members who've won the leading teaching award in the business school at the University of Washington. So he's been invaluable as a co-author on this textbook.

VIJAY MEHROTRA: Excellent. Well, I mean it's fascinating to see through this conversation how really in parallel, Fred, with your career, we've seen the field itself develop. And I ask you to think back at your first ORSA, your first TIMS conference, how many people were in attendance as compared to the several thousand that we have today?

FREDERICK HILLIER: I didn't quite catch everything.

VIJAY MEHROTRA: If you can think about your first ORSA conference or your first TIMS conference, how many people we had then versus today.

FREDERICK HILLIER: Oh, OK. The initial ORSA or TIMS conferences I attended, they struck me as being Stanford reunions because we had our graduate students and our recent graduates basically all there, and along with the faculty. And these conference were much smaller. You could actually read through the program and select specific papers you wanted to go to and you didn't have, what is it, 79 sessions now.

MARK HILLIER: Simultaneously.

FREDERICK Yes, 79 simultaneous sessions. So it has changed. And this comes back to the point I was

HILLIER: making earlier about how the field has evolved so much that now to do pathbreaking research, you have to really focus on a perhaps small area, become an expert in that area. Whereas back in my day, I could go off in various directions and that was OK.

VIJAY MEHROTRA: Well, and I think that in a way, you were uniquely suited to do that. The combination of the diversity of your background, your own personal tenacity. Boy, a lot of things have sprouted from those seeds over the last 50 years. I want to throw out a question, last question to both of you guys. What do you think the next 50 years has in store? Any particular trends or directions that you think we should be paying attention to?

FREDERICK HILLIER: Well, Mark hopefully will be around to see to find out what's happening 50 years from now. But let me just, while he's thinking about this, to mention a conversation I had with Peter Glynn, who's the current chair of the Management Science and Engineering Department that includes operations research at Stanford. He commented that he thinks that we're about to enter the golden era for operations research, basically because of the impact that the analytics movement is having.

That now these business leaders, CEOs, and so on down the line, top management who had never or barely heard of operations research before and were suspicious of these math types, what good they could do, they do understand about analytics and business analytics and are seeing some of the effect that this is having. And now, progressive businesses can't get along, it seems these days, without having some top analytics people. Well, what's the high end of analytics? Well, it's really operations research and management science that's providing the advanced tools for analytics to a great extent.

VIJAY MEHROTRA: With Mark here, I can safely add,,, facilitated by computer science and software people. Mark, do you have anything to add?

MARK HILLIER: Just the ubiquity of big data now is I think changing the field as well.

FREDERICK HILLIER: And that certainly connects with analytics, where the emphasis is so heavily on dealing with big data.

VIJAY MEHROTRA: As we look back on the earliest days of operations research, we remember our pioneers who emerged out of necessity during World War II and its immediate aftermath. But those pioneers needed followers. Smart, inspired, intelligent, motivated followers to embrace their ideas and to carry them forward into the post-war world. Fred was one of the very, very early wave of

these followers who was lucky to have a talented, intelligent, motivated guide like Jerry Lieberman to carry him forward. And his contributions to the field have been diverse and many fold.

More than anything, together with Jerry and later with Mark, Fred has really created a brightly lit, clearly marked doorway into the world of operations research and management science. And that world has played a big part in the analytics revolution that we talk about all the time today. So I want to extend a special thanks to Fred for sharing these recollections with us and for all of his contributions to the field.

FREDERICK HILLIER: Thank you, Vijay. I would like to thank Vijay for conducting this interview. Vijay was one of my favorite PhD students, a real Renaissance man who's making his own impact on the field these days. And thank you to Mark who, by the way, his older daughter is about to begin graduate studies in operations research. And finally, I would like to, if I may, dedicate this interview to the memory of my beloved Jerry Lieberman.