

ROBERT KLEIN: Good afternoon. My name is Bob Klein. I'm here today with John Little as part of the INFORMS History of Operations Research Project, and also the MIT 150 Infinite History Project. John is an Institute Professor and a pioneer in the application of operations research to business, and particularly to marketing.

I've known John since the mid-1960s, first as a student, then teaching assistant, then business colleague. I've had my own company, Applied Marketing Science, for over 25 years. And I once said that everything I needed to know about running a company I learned from John Little.

Now, a lot's been written about John's many accomplishments. And our intention this afternoon is not so much to repeat what has already been said or written, though there will be some of that. But rather to add John's personal style and voice to what exists in other media.

So to start out, John, tell us where you were born and where'd you grow up.

JOHN LITTLE: I was born in Boston on February 1, 1928. But I grew up in Andover, actually the West Parish part of Andover, which is sort of exurban at that time. My father commuted to Boston on the train. And I sometimes went with him.

But to add a little to the written record, I grew up in the Depression. And my father was a bond salesman. He had been-- he was, actually, always a writer. He worked for a while for the Boston Herald as a reporter and then a rewrite man. But he switched to the securities business and became a bond salesman.

But he was out of a job in 1933. They were jumping out of the windows in Wall Street in 1929. I was five years old.. Now, he eventually got another job. But in 1933, I started at something called the Pike School. Mrs. Pike had started a school in Shawsheen Village. She had a couple of grades there, and I started in first grade in 1933. The way things worked then, my father had chickens. And he paid for the tuition with eggs. [LAUGHS] I don't know anybody else like that, but I'm sure there are many. After two grades, though, I-- and I also started early. I started at five. There were no kindergartens then. So I started early and maintained that relative youth throughout my career.

But then I went to the Andover Public Schools. I went through the ninth grade. But I was good in school. I mean, I did everything well but penmanship.

ROBERT KLEIN: Uh-huh. OK.

JOHN LITTLE: [LAUGHS] So my father decided that I could get a scholarship at Phillips Academy, which is in Andover. so after the ninth grade, I went there. And I heard my father say, you know, astonishing things about my IQ and other things, which I'd taken a test.

So at Andover, I continued to be good in mathematics and the sciences. I remember my mother's asking me how things were going. I was a day student, first of all. I rode my bicycle to school sometimes. And then sometimes I had a lift from another person who was a day student. My mother asked me how things are going, and I said, fine. And then one day they had an awards ceremony. I won all kinds of prizes in mathematics, and even one in German, which I didn't think I deserved. [LAUGHS] But math and physics were easy for me.

So I came to graduate, and so I asked advice from my, I don't know, I think it was my physics teacher or math teacher, of where to go. And he said, go to MIT.

ROBERT KLEIN: Do you remember if you applied anywhere else, or was it just sort of automatic?

JOHN LITTLE: No. And I got a scholarship, which was essentially for-- and it was a remarkable scholarship. It paid tuition, which was, I think, \$300 a term. And an extra bonus. And it was preference would go Protestant white students from Brookline. And I wasn't from Brookline, but-- And so I went to MIT.

ROBERT KLEIN: So was majoring in physics sort of automatic?

JOHN LITTLE: No. I looked through the catalog, which was a big, thick thing then. Online now. I wanted to take all the courses. But I finally decided on physics as being something fundamental, and you could go places from there.

So I took classes. My grades started very high. I had, the first two terms, I had all A's. They were called H's at MIT at that time. But anyway. But two, essentially, B's, well, one each term, in mechanical drawing. So my penmanship was slipping.

So from that start, I went slowly downhill. d I became the editor of Voodoo. Voodoo is the MIT humor magazine.

ROBERT KLEIN: I was stunned when I heard that. Not from your lack of sense of humor, but just that I had never pictured you in that kind of a role.

JOHN LITTLE: Well, I have a few pictures. And the other thing that I would mention about MIT was that I had a minor in hitchhiking to Wellesley. [LAUGHS] And as it turns out, I married a Wellesley graduate. But not the one I was dating at the time.

ROBERT KLEIN: OK.

JOHN LITTLE: But the easiest hitchhiking I ever had was when I was dressed up in a tuxedo and I had a box of flowers in my hand. Got a ride like that.

ROBERT KLEIN: Always works. And so after MIT?

JOHN LITTLE: After MIT, OK. Well, I told you it went steadily downhill. I started in the summer. World War II was still on. It was 1945. MIT was on a schedule, a wartime schedule, which was three terms a year. And I was designated as 248, although I ended up graduating. I took a summer, I spent a summer in Texas on a seismograph crew.

But I ended up graduating in August, '48. The last summer, I got the first B I had ever gotten in a math course. And that shook me up. I wasn't doing the homework very well. But anyway. And then I also took a physics course.

And I did exactly one problem during the whole course. MIT is problem sets every week. And I did it, and it was-- I spent 25 pages on it and passed it in. And I got back to kind of a question mark. So I flunked that course.

So how do I accomplish this? Well, I was mostly sitting on the esplanade, listening to the concerts, lying on my back. And so at the end of that-- but I did graduate with a so-so cum. I mean, well, no, a pretty good cum. So I decided that going further in school would be a mistake.

And so I decided to hitchhike around the country. Hitchhiking was more common in those days. It's considered too dangerous now, but I don't think it's that different.

ROBERT KLEIN: I don't think so either. It was just as dangerous then.

JOHN LITTLE: It was just as dangerous then, right. I started across the top of the country. I stopped-- my father was working in Buffalo. But I had a friend of mine from my freshman year who said, you'll never make the West Coast.

So I was determined to make the West Coast. So I went across the top of the country. We don't have the super-highways then. And through Montana, Billings, Montana. I would stay at Y's and inexpensive hotels is what I would do. I remember Billings, Montana and Missoula. Wonderful towns.

And on into Washington state. In Washington state, I was picked up by a truck, a farm truck. And he said, kid, do you want a job for a while? And I said, sure. [LAUGHS] And so I worked on the sheep ranch. That was very interesting. The people were very interesting.

ROBERT KLEIN: Yeah, I bet.

JOHN LITTLE: They lived outdoor-- there was one guy who had been in a forest fire. And so one side of this faced was completely scarred. And there was another who was so quiet, I mean, he spoke in a whisper as we ate. So that was good, and I earned some money.

But I still wanted to get to the West Coast. So I went on to probably Portland, or I went on to Washington and down the coast, the Cascades. And I remember hitchhiking into San Francisco. I got a ride with some con men. Now, there was a chief con man who had been taught by somebody else. And what he had was two apprentices. And they were going to San Francisco and stay at a first class hotel and exit without paying the bill.

ROBERT KLEIN: OK.

JOHN LITTLE: So we rode down. And I left them and I have no idea what happened. I stayed at the Embarcadero YMCA, which I assure you-- which was a big room and with cots in it. Next to me was a sailor. And while he was asleep-- he had put his wallet in the pillowcase. And while he was asleep, somebody had slit the pillowcase and taken his wallet. That's the Embarcadero Y. It's long since torn down. d I also went to the symphony courtesy of a friend of my mother's - was asked about the symphony -. I said it was fine.

But then I went to LA, stopping with people I knew along the way. And then I decided I'd go home for Christmas. I hitchhiked Route 66. So I have hitchhiked old Route 66. There's a song about that. I remember it's something about Flagstaff, Arizona. I was frozen to death in Flagstaff. It was windy and wintery. So I went home. And then I went down, then, after Christmas, I decided I'd go to Florida.

So I went down to Florida. And it turns out that everybody else was there too. All the hitchhikers and hobos were there. So I decided to go visit my sister and brother-in-law who

were in Austin, Texas.

And on the way out of town, I rolled over in a car. I was driving.

ROBERT KLEIN: Oh, OK.

JOHN LITTLE: A salesman-- frequently, the drivers are salesman, hitchhiking. I was driving. He said, we can continue on. And I said, fine. So I was driving. Up ahead, a car-- actually, it was a new car - its right rear wheel skidded off the road and he lost control of it. And it came across and swiped our bumper. And he went backwards into the ditch.

We rolled over. I remember thinking I'm OK. And I said, but it isn't over. We rolled over and came up on the wheels. The state police came by. I give them a lot of credit. They figured out exactly what happened. And after that, my salesman remembered it exactly.

[LAUGHS]

So there were adventures. There were other adventures.

ROBERT KLEIN: But then you went to work.

JOHN LITTLE: But then I went to work. I went to work at GE in Schenectady. I had interviewed there when I was a senior in college. They'd offered me a job, but I decided to go hitchhiking.

I told them I'd been hitchhiking, and they were extremely pleased [LAUGHS] that I'd made it back, I guess. So they gave me a job.

I joined what was known as the physics program, which is rotating assignments in various locations. I was at the low temperature lab and the tube division. I met my wife to be, because she was a graduate of Wellesley-- but I hadn't known her there-- and was in the physics program, which was striving to get another talent pool besides electrical engineers.

ROBERT KLEIN: Were there very many women in the programs, science programs, at that time.

JOHN LITTLE: There were two in the physics program, this physics program at GE.

ROBERT KLEIN: Out of how many?

JOHN LITTLE: Out of maybe 20. Anyway, so she and I both pseudo-independently decided to go back to graduate school. So we interviewed and filled out forms, and interviewed in some places. We

interviewed together usually.

And I remember the form for the University of Chicago. It was so long, I refused to fill it out. [LAUGHS] I think she was admitted to there. But she was admitted to a lot of places. I was admitted to MIT. I asked my initial registration officer, I said, what about those courses I flunked?

He said, oh, I don't know. I guess if you're admitted, you're admitted. We'll forget about that. So I was still restless. I had a friend named Fernando Corbat³. I lived in what was then the graduate house. It later became Ashdown, and now it's Maseeh Hall. And it's at the corner of Mass Avenue and Memorial Drive.

But after a while, we decided that it would be good to get an apartment. So we got an apartment over on Beacon Hill. It was on Myrtle Street. It was \$40 a month, rent controlled.

That was pretty expensive as far as we were concerned, but it had been occupied by an elderly couple and a dog. The place was an awful mess. So with elbow grease and what have you, we painted it up, and we became the inhabitants.

I was still dating the same woman, Elizabeth Alden. Eventually, we got married and moved to Marlbororough Street in a fifth floor walk-up. I had a bicycle. It was World War II Victory bicycle with one speed. But it was OK. I used to commute.

Now, meanwhile, I was still restless. I passed my general exams in physics. My registration, the graduate registration officer was Philip Morse who was a World War II operations researcher. There's a book by Morse and Kimball, which is a collection of World War II declassified examples. It's called Methods of Operations Research.

So I was looking around for a thesis topic. And also, I had taken-- I was kind of restless. I'd taken a TA, or an RA with JCR Licklider, who was actually a fairly well-known psychologist. And he was great, but I didn't want to go into psychology.

But I made some movies with him where I advanced little objects on a felt blackboard such that a series of stills turned into a movie. Anyway, so Morse said, would you be interested in an operations research thesis? Meanwhile, as a matter of fact, I had an RA in machine methods of computation, which Morse had. And that was supporting me.

And as part of this RA, Corby [Corbat³] and I computed a table of spheroidal wave functions.

OK. Well, I have to-- well, they were esoteric functions.

ROBERT KLEIN: [LAUGHS].

JOHN LITTLE: And these were only the coefficients for an expansion in spherical Bessel functions. But anyway, so we did it. But we did it on Whirlwind. Now, Whirlwind was a digital computer which I learned to use and Corby learned to use. And he later on became, essentially, a well-known professor of computer science.

Then I heard about a project that was out of the EE department. And it had to do with hydroelectric systems and the Bonneville Power Administration. They wanted some research done on it-- Morse wisely felt that that could be an interesting thesis. But he would keep me on his payroll because he didn't trust the engineering department. Exactly. So that's how I did my thesis.

And what I did was I came in - Morse saw me weekly for maybe a half an hour. And I sat on an uncomfortable couch, which I'm sure he sat people that he wanted to get rid of. But he sat over near the window. And he had a tiny postage stamp of a blackboard which you couldn't get any equations written on. And ever since then, I've had a big, big blackboard, or a whiteboard.

Morse suggested I work out an example. So I sat down to work on my example. Then I had an idea. remember crossing Killian Court-- it was then Great Court-- and saying, I've got it. I know how to do it. Because the basic problem is-- here's Grand Coulee Dam [shows photo]. And you can see the water is rushing over it. That is wasting energy for the Bonneville Power Administration. And what it means is that the water is not going through the turbines. So this is, basically, the spring runoff season, when it looks beautiful, and a tourist attraction.

Now, in the fall, the snow falls in the mountains-- the rainfall, the precipitation is in the mountains, and it falls as snow. And the stream flow goes very, very low. But there is stream flow, and it's a lot of variation.

We had records for 50, 60 years. And the problem is that you have a big reservoir of water, which is really latent energy. However, if you start drawing down the reservoir because the stream flow is low, you'd drop the head. And head is water times stream flow plus any discharge you elect to take. That's the energy.

And so you want to draw down the reservoir, but you don't want to get it all done because then

you would have very low head. However, you want to get it done before the stream flow, the next flood comes in. So that was it.

And as I was walking across the Great Court, I said I've got it. I know how to formulate. So I went back and wrote it down. And I told Morse about it. Oh, and I started using it. I started programming it. And I told Morse about it.

And he said, is this the way you want to do it? [LAUGHS] And I said, yes. He said, OK. And it was-- actually, I'd reinvented dynamic programming, which Richard Bellman was then at RAND writing about it. And I told Morse about that, because a paper appeared in the Journal Operations Research, and I told Morse about it and he said, well, we better finish it and publish it.

Anyway, let me tell you about Whirlwind. That's the object of my affections - the Grand Coulee Dam. And here is a picture, carefully posed, of the control room for Whirlwind. I describe it as my personal computer, 1952, '54. Actually, the purpose of Whirlwind was for air defense. It was a prototype computer for air defense. And so the work during the day was totally classified. But in the evenings, Corby and I had it-- well, not to ourselves, but there were some other people too. But I called it my personal computer.

And this is a picture of what I call the motherboard, Whirlwind motherboard and CPU. 1952.
ROBERT KLEIN: It's huge.

JOHN LITTLE: That's right. It's huge. And you can see all the people out posing out here. And that person is Jay Forrester. I didn't know him at the time. I now know him at the Sloan School, where he's changed careers. But he was in charge. And he has the patents on some--

ROBERT KLEIN: Core memory.

JOHN LITTLE: --core memory, right. And this picture is the output. Whirlwind had a camera which took photographs on command. And this picture shows-- the top graph is stream flow. What you see is off scale at either end because of the runoff. And then it goes down and is to low level and then starts picking up again.

OK. Now, my algorithm is working here. And this is, essentially, what you would have to pay a power company, a steam driven power company-- this is the number of kilowatt hours you would have to pay them. And this is the height of the reservoir. And you can see it dips down

in the fall and winter, and then rises rapidly in the spring.

And I also want to point out the clock which is photographed by the computer. And the data is September 18, 1954, and it's AM, so I'm in the last stages of my thesis then. And it's six minutes of 7:00. ROBERT KLEIN: So that was your thesis.

JOHN LITTLE: That's right.

ROBERT KLEIN: And you graduated with a degree in operations research?

JOHN LITTLE: Well, I've always-- well, I did my general exams in physics. There weren't any OR courses. There was one by George Wadsworth in the math department which I took. But by and large, there weren't any courses.

I took courses in partial differential equations and other interesting stuff as part of my physics training. But I generally list my thesis as physics and operations research. Given enough space, I will say that I passed my general exams and I wrote my thesis in operations research.

ROBERT KLEIN: And then from there, a little time in the Army.

JOHN LITTLE: Yeah. Well, at that time, what I was facing, I mean, I just missed World War II. So I had a draft liability until I was 35. And when you're 25, 35 looks like infinity. So I said, I'll get my service out of the way.

So I let myself get drafted. And Betty stayed with my mother in Andover for a while. And I went drafted. I did basic training in Fort Dix, New Jersey. And then the Army had decided to not be as stupid as in World War II. So I got a special assignment, which was doing military operations research at Fort Monroe, Virginia.

I was working with field grade officers who were very nice. We ignored the ranks, because I had a PhD and they didn't. And there were some civilians also with PhD's. And except that I was called out every now and then to do KP, why, everything went smoothly.

I bought a boat. Betty and I scraped up our, really, fortune, which was \$900. And bought a boat which was considerably bigger than a lot of the officers' boats. But it was a sailboat. And not many of them had sailboats.

So we got in trouble all over Chesapeake Bay. And had a great time. And OK. And I have pictures. We named the boat Queequeg. Queequeg is a very positive character in Moby Dick.

And then we had our first child, which was Jack-- John N. Little, who will reappear later.

So then we took a job at Case Institute of Technology in Cleveland. That was actually a pretty productive time. The way it worked was that Russ Ackoff-- there was Ackoff, Churchman, and Arnoff who had an early book on operations research. But Russ Ackoff was the salesman. And he used to sell projects to various and sundry people.

And some of them were in marketing. I mean, a lot of them were in marketing. That got me exposed. We had a project with M&Ms candies. And I've had dinner in the dining room of the Hackettstown Inn with Forrest Mars, who eventually got control from his sister and was, for a while, the owner of Mars and M&Ms candies. I think it's still a private corporation, and extremely rich, and extremely successful.

But the way that the plant was organized was everybody was in a big room. I mean, the desks were stationed so you could get in between them. But the problems were interesting. They were a very gutsy company and very experimental. For example-- and we were consulting for them and analyzing their data. And I first learned what a promotion was from their sales data. It's actually shipments.

But they had these huge peaks in them. And I said, "that's not a Poisson process". And they said, "oh no, that's right. Those are promotions". And we run a promotion, and the trade stocks up on it. And big peaks.

So we analyzed some of their data. And they decided, with some prodding, with some suggestions from us, to run an experiment. So they took maybe a third of the country, I mean they weren't cheap, and they stopped advertising. I also learned about advertising agencies and their reps.

So nothing happened. They waited a few months. And it started to go down. And they waited another three months, and it started to go down fairly abruptly. They said, OK. We'll start advertising again. Mostly it was spot advertising.

We analyzed this to build a kind of a response curve. We presented our results. And there was one feisty member, a graduate student, who converted this marginal analysis into what he called a rule curve, which was a graphical way to reward the agency on a marginal cost basis for finding lower cost spots.

The agency was up in arms. And I think they probably correctly-- but they never-- M&Ms never

implemented that. But anyway, there was another project with Standard Oil of Indiana. And it was on gas stations. And an executive of Standard Oil in Indiana said of Russ Ackoff, I'm not sure what he's selling, but I want to buy some of it So that's why we had the project. And Russ was like that, very controversial guy.

ROBERT KLEIN: So that was really your introduction to marketing, and operations research and marketing.

JOHN LITTLE: That's right. And I had a course, operations research and marketing. It's based on these things, and little problems I made up. And we had Cummins Engine, which was another one of them.

Also, while I was at Case, I wrote a paper which has become Little's law. And I'll give you the title of the paper.

ROBERT KLEIN: I've got it here. "Proof of the queuing formula of $L = \lambda / \mu$."

JOHN LITTLE: Thank you. I know it as Little 1961. **ROBERT KLEIN:** Yeah, right.

JOHN LITTLE: OK. Well, when I first came to Case, Russ said, Little, you're from MIT, how about a course on queuing? Well, I was at MIT, yes. But I had my nose in hydro systems, not queuing. But that's OK. I'm game to learn.

AMorse did a lot with queuing. He wrote a book called Queues, Inventories and Maintenance, while I was there at Case. And I started using that as a text. And this formula was widely known at the time. However, it was known in specific cases. Poisson arrivals and exponential service, for example, was standard case. Beautiful, simple mathematics. So as I was teaching the course, I was kind of challenged by a student, Sid Hess, who actually was a chem engineering graduate of MIT.

I was telling people that the formula was much more general. And I had a heuristic argument with pictures of things, queues. And the class understood my argument. And they said, well, how hard-- well, Sid asked, how hard would it be to prove it formally?

I said, well, it shouldn't be too difficult. Famous last words. So he said, you should do it. All right. So anyway, I bought some books and I took them to Nantucket where we spent the summer. And I worked on it there.

Eventually, I wrote it up and I send it off, and it was published. All right. So what I thought at that

point-- and the way I went about publishing it, thinking about it, was you need something more general. So I bought math books.

I bought a bunch of math books and learned a bunch of mathematics. And worked out a proof. But I said, I don't want to be a mathematician. I want to be an OR person. And so I want to-- I'm not going to do any more of this. So I forgot about it. But for four years - that came back. But that's a really different story.

ROBERT KLEIN: So after Case, then you came back to MIT.

JOHN LITTLE: Yeah, back to MIT. Oh, one other thing I did at Case was I had student who came to me with a proposal to solve a traffic signal problem. And he had data from Waltham-- or the geometries of Waltham, Massachusetts. I don't know where he got them. But we published that, and that was a pretty good paper.

Then OK, it's back to MIT. And at MIT, I continued that line of work, and generalized the problem of synchronizing traffic signals to a grid. And that was that. But I also published, while I was at MIT, a paper on the traveling salesman problem, which has a particular contribution by me.

This had started at Case too, with a student named Katta Murty. And he had a tree method, and he was solving with the trees by assignment problems. And we ended up with multiple authors, but the last author was a Sloan Fellow at MIT, who I said we'd like to do some calculations with this.

He was from IBM, so he had access to computers. And in fact, I think we did use the IBM at MIT. But he was willing to do the programming. And he suggested a new idea. Well, let me interrupt and give you my contribution, which is lingual.

I understood everything. It's actually pretty simple. What you do is you have a tree. You can represent the various alternatives as a tree. And the traveling salesman problem is how to go to a bunch of cities and have the shortest path, the shortest connected path.

There'd been examples where people had worked them out laboriously by hand, special arguments. But we were-- Katta Murty and I and Dura Sweeney, the IBM guy, were looking at this tree. And what I needed was a way of describing what we were doing.

And I remember going up-- and I finally had a way to describe it. And I remember going up

and telling my wife that I had it. And it was Branch and Bound. So what you have is a tree with a node at the top. And you go down, down, and you go down. And you have these nodes. And you have-- I don't know, it looks like a tree.

And what you do is at each node, you're going to select a branch to go on. And the way you do it is you calculate a lower bound on what you can find on that branch. And each subproblem-- as Katta Murty was doing assignment problems. But what Dura Sweeney observed was they were traveling salesman problems, which gave a tremendous symmetry to the whole algorithm.

So at each bound, we set up a new traveling salesman problem-- at each node. And we found a bound on the most you could hope to get out of that direction. And that's the way we solved it. As I used to say, we set the indoor record for size of-- we drew matrices at random. And we had the indoor record, which was 40. So anyway, but Branch and Bound has been picked up and is throughout the literature as how you approach these problems. And it's also-- there are variants, branch and do something else.

ROBERT KLEIN: With a lot of detours into traveling salesman and stuff, you really got involved in marketing, full time then in the mid-'60s. **JOHN LITTLE:** Right. That's when I think, well, what year is your master's degree?

ROBERT KLEIN: Mine was '68.

JOHN LITTLE: '68? **ROBERT KLEIN:** Yeah.

JOHN LITTLE: Well, we had the marketing game.

ROBERT KLEIN: Right.

JOHN LITTLE: And you were my TA for the marketing game. But I was really in marketing. We had a new marketing group with Glen Urban. We had Arnie Amstutz for a while. And a very creative guy. But also a creative businessman.

We had Al Silk, and later Rick Bagozzi. We had a lot of good people. And then a student that turned up at the OR center, and I was technically his supervisor, and that was John Hauser. And he was turned on by a paper we'll get to.

But prior to that, I had a student in the Sloan School, Leonard Lodish, who had an

undergraduate degree from Kenyon, I think, in mathematics. But he was interested in OR. But he tells me that he went around to Miriam Sherborne who was an administrative woman who glued the school together.

She recommended that why don't you-- Len asked her advice and she said, "why don't you go talk to John Little about marketing?" So he came. And he found me working on a media problem. And we co-published a simple model in this Industrial Management Review.

So then I started working on MEDIAC, which is a careful analysis of the media problem with definition of terms and models, which viewed advertising as, essentially, exposures as a little jump in your perception, and then a slow decay. And we formulated that and eventually published it in Operations Research. And we had data and all good things.

ROBERT KLEIN: Were you working with any agencies at the time, or was it--

JOHN LITTLE: I think not. I think not. But Len wanted to form a company. He was influenced in this by Arnold Amstutz, who was always forming companies. [LAUGHS] So I said, well, we have to do some market research. And so I reached around behind me and got the Boston Yellow Pages and looked for ad agencies.

There were many, many ad agencies. And I said, that does it. Let's form a company. But Len was a lot of the stimulus. And he sold the first project. It was to a company in Providence, which I don't recall a name. And we formed a company.

He put in \$500 and I put in \$500, and we incorporated. Then my then secretary, Betsy Wood, went to work at Young & Rubicam. And her boss at Young-- she told her boss in New York about our company and our computerization of the media selection process. I mean, which has never been-- well, there's stuff in the literature, but not very much. And most of it is not real life.

So we were eager to use it. And so we wrote a contract with Telmar, which was hideous in retrospect. We were so afraid we were giving something away we shouldn't. But it all worked out because everybody was good friends.

And they started-- and the gentleman at Young & Rubicam was named Stan Federman. And so Len and Betsy Wood and Stan were the major show. And they added other people. And Stan went out and sold it.

I remember going to New York. I forget, there was a staunch researcher, a well-known advertising researcher, who-- a couple of them-- who liked our work. And so they were off and running. Telmar still exists. Stan Federman is long since retired, and Len has retired too.

ROBERT KLEIN: Is that the first marketing model that you sold?

JOHN LITTLE: That's right. But I think-- that's right. And Len sold it. I did the research. I did the yellow pages.

[LAUGHTER]

ROBERT KLEIN: But I think putting a name on a marketing model and then selling it--

JOHN LITTLE: That's right.

ROBERT KLEIN: --is turning it into a product.

JOHN LITTLE: That's right. That's a product. I don't know how we protected it, but later at MDS, we did that. Oh, and the name of the company was Management Decision Systems, or MDS. Meanwhile, back at the ranch, we hired a couple of programmers. Glen Urban was getting in the act.

We hired a couple programmers, who were MIT undergraduates. And I began developing models. And so did Len. Len built-- developed a product called CallPlan, which helped a salesman plan his calls and route.

ROBERT KLEIN: How many times to call on each-- each of his customers.

JOHN LITTLE: That's right. And then we got a project with Nabisco. I don't remember. Oh, we ran two-week summer courses. And explained what we called "OR and Marketing" or "Management Science and Marketing". We had people come in and we explained what we were doing. And Glen would talk about his stuff. I would talk about MEDIAC and Adaptive Control, which is another model I developed.

So we were off and running. But it turned out that software was part of the-- we hired, among other people, Bob Klein. [LAUGHS] What was your number?

ROBERT KLEIN: I was number two, and a full time employee.

JOHN LITTLE: Full time employee.

ROBERT KLEIN: I missed being number one by a month.

JOHN LITTLE: I see. Who was one, Rick Karash.

ROBERT KLEIN: Rick was the first. He got laid off from Data General, or from Digital, I think.

JOHN LITTLE: I see. Well, we hired our students, basically Master's students. And Len now had his PhD. Our tool was the computer, and our mathematics were marketing models.

The principals, who were the academics and wanted to stay academics, felt that what they would like to do was do the first application of the new model, and then publish it, because we're academics. And then turn it over to others, which were smart Master's students. And that worked very well.

ROBERT KLEIN: The computer systems that were developed, and we had time sharing, and that was the access to computers at that time.

JOHN LITTLE: That's right. There was a project at MIT called Project MAC-- M-A-C in capital letters. And it stood for Multiple Access Computing and something else. I don't know what the other thing was. But it essentially was taking a mainframe and timesharing. You had to have an operating system, and you had to do things to make that possible. And it was-- I mean, it still exists in big mainframes, but it's basically supplanted by the personal computer, and now the handhelds.

ROBERT KLEIN: These summer programs, is that where the contacts with Nabisco and Coca-Cola came from?

JOHN LITTLE: Right. So I did a project as a result of this. I did a project with Nabisco, a model building project. And also at Coca-Cola. This was an extraordinary good fortune because they had totally different products and distribution systems. Nabisco had cookies and crackers, basically, and plants to manufacture them. And then salesmen who go into the supermarkets and set up and deliver the product, at least in those days.

And Coca-Cola doesn't make any soft drinks. It only makes syrup. And it has a huge distribution system. Well, what that means is that there's nothing in Atlanta but a big building, which supervises the distribution system. And they have bottlers out in the boondocks who are frequently independent operators, or might not be.

So it was wonderful. And Coca-Cola was very interested in advertising and things having to do with that. But they monitored their distribution system constantly. And they were able to do experiments.

ROBERT KLEIN: How important was it to be working with people inside companies like that for both ideas as well as a classroom?

JOHN LITTLE: Yeah, well I often claimed that my license to go into a classroom and talk about marketing is really based on having the MDS firm doing it, and being there with brand managers as they talked about their problems and are our models relevant?

ROBERT KLEIN: The "Models and Managers" paper from 1970, I mean, I remember reading it in Management Science, sort of after we talked about my coming to work for Management Decision Systems, but before it had actually happened, because I think it came out in April of 1970. And I was just blown away by the basic concepts and what makes a good model, and that whole-- the whole picture. What motivated you to write that article?

JOHN LITTLE: Well, like many things, it sort of came together quickly. Although I spent a lot of time working on various-- writing it. But let's talk about heretofore the econometricians count on having a big database with a lot of observations. But they work-- I mean, particularly in those days, they work with linear models. And it's not very hard to see that linear models don't work.

For example, in advertising, a linear model of advertising would say, as a decision tool, you would either advertise at zero or infinity.

ROBERT KLEIN: Right.

JOHN LITTLE: So we weren't doing that sort of thing. And we had more complicated models. And finally, I kind of threw away a constraint. The constraint was that you had to have data for everything.

What I saw people doing is using their own good judgment. They would stare at the data and make up their mind. So why not go to them for their judgment? So I started building models which were judgmental.

I said, let's take advertising. We now have a given level of advertising. Now, what would happen if we had all the advertising we could possibly use? How high would sales go then? OK.

Suppose we take our current level and increase it 50%? How much do you think the sales would go up? And also, suppose we cut advertising and didn't do it? How low do you think the sales would go?

So asking these questions of people, and there's a lot of data. In other words, they know what kind of normal sales are. And they've been fiddling with their advertising. They have a guess at how much it would go up. And what the limits were. I mean, they're just physical limits.

ROBERT KLEIN: Yeah. I remember running those kinds of workshops with a half a dozen marketing guys in the room, and the people from an ad agency, and brand management. And they would make their estimates. And we'd have them do it separately. And then I would tally up what the median turned out to be.

And people would argue about it and stuff. But you're right. They have their own internal models. People make judgments. And when you make them explicit, then they're able to say, OK, well, if this is what I really believe, then here's what I ought to do.

JOHN LITTLE: That's right. And there's data analysis, in fact. But what I ended up doing was writing a paper, which I think summarized my impressions of what we were doing in the field in various kinds of models. Glen had his whole series of models. And he had specific measurements - he did. But that's fine, that fits in.

So I wrote a paper called "Models and Managers: the Concept of a Decision Calculus." And I called the product of this a decision calculus. OK. And my first sentence of this paper, is-- and this paper developed-- let me to throw in an aside.

This paper developed a following. And was deemed one of the 10 most influential papers in management science in the first 50 years, which I felt very flattered about. But my first sentence is: "The big problem with management science models is that managers practically never use them." It's not a negative paper. But I sort of characterized the problems. And I suggested characteristics of the model-- that a model should have, which I felt made it more appealing to managers.

And so there's a list of maybe seven. A model to be used by a manager should be simple, robust, easy to control, adaptive, as complete as possible, and easy to communicate. By simple, I meant easy to understand.

By robust, hard to get absurd answers from it. By easy to control, that the user knows what input data would be required to produce desired output answers. Adaptive means that the model can be adjusted as new information is acquired. Completeness implies that important phenomena will be included, even if they require judgemental estimates of their effect.

And finally, easy to communicate with means that the manager can quickly and easily change inputs, and outputs-- change inputs and obtain and understand the outputs. So that summarizes a 30 or 40 page paper.

ROBERT KLEIN: Well, and I've, in my career, made that kind of required reading for people who work for me. If we're doing something that the client doesn't understand, they're not going to believe it.

JOHN LITTLE: That's right.

ROBERT KLEIN: So all of those things are really critical in any e-marketing model. When did the term Marketing Science emerge? I mean, there's the Journal of Marketing Science, but before that, there was sort of a concept of marketing science, even though some people would argue that marketing isn't a science, or it would have at that time.

JOHN LITTLE: Yeah. Well, let me take care of the journal, because I think the journal will reinforce the term. Of the two professional societies that were rather duplicative, and eventually, I was involved in their merger. The Operations Research Society of America - ORSA - and TIMS, The Institute of Management Sciences, did a lot cooperatively. I had traditionally published in Operations Research. And have many papers there, o although this "Models and Managers" happened to be in Management Science. But of the two societies, at one point, as more and more stuff was coming out in what could be called quantitative marketing and measurement, I think I was president of ORSA. And Frank Bass, of the University of Texas at Dallas, was president of TIMS.

And TIMS had a very strong group, a subsection called the College of Marketing. And we were both in it. And they actively had conferences, and dealt with marketing issues and models. So at one juncture, Frank and I got together and said we should start a new journal for this stuff.

I wanted it to be a joint journal, and so did Frank, as far as that goes. So he didn't have any problem with the TIMS council. I had a little problem with ORSA council, which finally said, oh, let John have his journal. And we named it Marketing Science.

Very interesting, Bill Pierskalla, which was the name of the editor of Operations Research at the time, stopped publishing marketing articles. Not so the editor of Management Science, who's continued to publish some, and had special issues on marketing. That is, to some extent, true to this day. Both journals are now under the umbrella of the society INFORMS, but there's much less marketing in Operations Research than there is in Management Science.

Anyway. So I think it was going on. It was going on, and both Frank and I were publishing. And this paper was one of our products. And it's certainly-- and the illustration-- the concept is more general, but the illustration is strictly marketing.

And we learned a lot in MEDIAC and Brandaid, and applying these models in the world. Brandaid was another-- it was a two-part paper. One some theory, and the other an example. It basically was Oreos.

ROBERT KLEIN: Yeah. What were some of the lessons that you drew from your Management Decision Systems on entrepreneurship that you showed there?

JOHN LITTLE: There was a session in Maryland, we had a conference in Maryland. And Bob [Klein] gave a talk. [LAUGHS] And he's mentioned one of the things.

ROBERT KLEIN: Well, I think running a company forces you to to address a lot of issues that marketing models maybe can gloss over.

JOHN LITTLE: That's right.

ROBERT KLEIN: But at MDS, there's a big transition from the software to support models and building models like Brandaid, and Sprinter, and CallPlan, and so on, to software for building Decision Support Systems.

JOHN LITTLE: That's an excellent point.

ROBERT KLEIN: The term Decision Support Systems, did you coin that as well?

JOHN LITTLE: No. Let's see. No, I won't say Michael Scott Morton coined it. He coined Management Decision Systems. And then he had to have something else. Peter Keen, I think, was another faculty member at Sloan, and Michael was in information systems area. But it was descriptive.

The thing is, I like descriptive titles. Decision Support System is descriptive because it implies data, and software, and access. And actually, you get to models. And perhaps it's time for another anecdote.

We had these software developers. And there was one-- and I don't think he ever got a master's degree. Jay Wurts.

ROBERT KLEIN: Jay, no, I don't think so.

JOHN LITTLE: No, never did?

ROBERT KLEIN: No.

JOHN LITTLE: Well, it's because he was too busy making money. But his view of the world was: you people think that these models are all different. I think they're all the same. And what I would like is some budget to implement a more general scheme.

I remember, I was sitting in Nantucket where we used to go to our house down there, and talking to Jay about software requirements. And I said, you have products, but you will likely have multiple products. You have time periods, but you might have weeks or months or any time period. And then you have geography, you have multiple cities or markets.

And you have at least those three things, and probably we can think of some more. And Jay said, you'd like to specify it at run time. And I said, well, that would be nice. And so he built it. And he added all sorts of functional capabilities. I mean, you can add, multiply, and so forth; age the time series. What you had was the ability to give a name to the months. It could be February, March, and April. Or give a name to the markets. It could be New York and Chicago and LA. And multiple products. And it just worked.

And you could take a bright, Master's degree or MBA-- now it's an MBA, it wasn't then-- but an MBA from MIT or Wharton, and they could, with very little training, operate this thing and set up databases. And so as a consulting company, we had people doing miracles.

ROBERT KLEIN: Well, I mean, companies like Nabisco and Coke had just mountains of data. And if a manager wanted to know what were sales in Chicago last week, the guy would run off and a day later would come back with the report. And the manager would then say, well, is that up or down from last year. And back and forth and back and forth, and weeks would go by before the manager really got the answer to the question. And EXPRESS let--

JOHN LITTLE: That was the name of our software, EXPRESS.

ROBERT KLEIN: But let people first get access to this information very quickly, but then also do all sorts of transformations to it to get the answer to the question they were really asking.

JOHN LITTLE: That's right.

ROBERT KLEIN: Tell the Coke story.

JOHN LITTLE: Yeah, I have a Coke story, which I think that this MBA here is John Reid--

ROBERT KLEIN: Probably.

JOHN LITTLE: --who has a piece in the Sloan-- has a quote in the Sloan 100th Anniversary book. And he's at a higher level in the company than he was then. So I will scan this and read it.

“Once upon a time (which is 1973), an MBA student took a summer job with a large food manufacturer (namely Coca-Cola). He reported to Management Science in the principal division of the company. The MBA was assigned to put key marketing information (basically store audit data), on a time shared computer. (And this would be in EXPRESS).

“The goal was an easy to use retrieval system. (OK. He did this). By the end of the summer, word of the system had reached the marketing manager of the major product of the division, who asked for a demonstration. The MBA and the management scientist showed the marketing management how simple English-like commands could retrieve data items, sales, share price, distribution level, each by brand, package size, and month. (Package size is another thing, brand is another dimension). The marketing manager was impressed. You must be fantastically smart, he said. The people downstairs in MIS have been trying to do this for years and they haven't gotten anywhere. (This is typical of that senior management of that day in their MIS departments).

“It was hard for the MBA to reject this assessment out of hand, but he did acknowledge (and this is the key point) that software has changed,)and high level analytics languages are available on time sharing) and make it easy to bring up such systems. OK, the MBA and the management's scientist, flushed with success(we essentially were dealing with the management scientists, and the MBA eventually went to work for Coca-Cola”. He said, ask us anything.

ROBERT KLEIN: Famous last words.

JOHN LITTLE: “Well, the marketing manager thought a minute and said, I'd like to know how much the competitor's introduction of the 40-ounce package in Los Angeles cut into the sales of our 16-ounce package. Well, the MBA and the management sciences look at each other in dismay. What they realized right away(and what you might with a little thought) is there isn't any data in the computer about sales that didn't occur. So this isn't a retrieval question at all. It's an

analysis question.â€ OK. Now, the marketing manager had no idea that-- I mean, it was just a fact as far as he was concerned. And so why wouldn't it be there? Now, what you need to answer the question is a model. And in this case, it's a pretty simple model that you could-- and then we sat around at the time and we talked about it. You could take the market share before the competitive introduction and extrapolate it forward, and assume that that's the baseline reference point.

And then calculate how much that share, and therefore sales, you had lost in this time period. But the miracle of the EXPRESS software, compared to its competition, was that a few keys pushed on the keyboard, and out came the answer, in sharepoints, in cases, and in ounces.

There are a few lessons that I drew for this paper. And that is, managers ask for analysis, not retrieval-- as well as retrieval. Good data is vital. You've got to have it, and it's got to be in there, and it's got to be right. You need models. They're often simple models, but you need them to give the full picture of the market.

And you need an intermediary. The well-trained management scientist at Coke was such an intermediary. I mean, I've seen when-- I think it was also at Coke-- when somebody had a keyboard, had a program going, asked the manager to sit down. Well, he didn't know where the keys were. And it was very quick-- very, very quick to find a substitute.

But another lesson was quick, quick, quick. If you could answer the question when it was asked, essentially immediately, it made all the difference in the world. And one question leads to another. And you're problem solving on the computer. And that's because this of the software. And we did very well with it.

ROBERT KLEIN: I mean, it's really the On Line Analytical Processing, OLAP.

JOHN LITTLE: Yes. Yes, oh that's right. OLAP. I had forgotten. I was trying to remember the term. But there's also another element. It's the multi-dimensional database, which was ignored by MIS for a long time in favor of relational databases. Well, relational databases are great, but OLAP was essentially the answer, Online Analytical Processing.

ROBERT KLEIN: EXPRESS, a core of that actually still exists inside of Oracle--

JOHN LITTLE: Right.

ROBERT KLEIN: --in their system.

JOHN LITTLE: MDS, or IRI, actually, by that time. MDS was absorbed by IRI, Information Resources Inc. in 1985. And later EXPRESS continued to develop. And eventually it was sold to Oracle for \$100 million.

ROBERT KLEIN: And Oracle-- and there's still some of the old MDS people are still there, still at Oracle, keeping--

JOHN LITTLE: Yeah, Phil Johnson.

ROBERT KLEIN: Phil Johnson and Andy Goldberg.

JOHN LITTLE: I see.

ROBERT KLEIN: So--

JOHN LITTLE: How about UPC data?

ROBERT KLEIN: Yeah, UPC data came along then and sort of change things by an order of magnitude, at least.

JOHN LITTLE: Right. We at last had data. I mean, before that we had factory shipments. And there's all sorts of problems with that.

ROBERT KLEIN: Plus it's only your data.

JOHN LITTLE: It's only your data.

ROBERT KLEIN: You don't see the competition's™s.

JOHN LITTLE: UPC data was everybody's data thanks to well, I guess, Nielsen and IRI. UPC stands for Universal Product Code. It's the bar codes on the side of your package. And there are a couple things we did with that. One, Peter Guadagni was a master's student of mine at MIT. He had a summer job with Bob Klein. He's a very smart guy. I had lunch with him last week in San Francisco. But we got a hold of some panel data. And I don't know, you can probably tell the story of its acquisition better than I.

ROBERT KLEIN: Well, this was the Kansas City panel. This was six stores in Kansas City where SAMI, which was a division of Time, Incorporated, and they were collecting warehouse withdrawal data. And saw the UPC data, scanner data, as being a step closer to the actual sale of the product

than warehouse withdrawals. And so they were trying to run a pilot program in Kansas City where people would show a card when they checked out. Now everybody, of course, shows their loyalty cards. You've got a keychain full of them.

But they would trade-- people would show these cards. And so you would have a complete record of not just what the store sold in a week, but what a household had purchased over a period of time. And they took the coffee category and made it available for academic research.

JOHN LITTLE: And we used it. Peter used in his thesis. And the underlying technology is the so-called logit model, multinomial logit model. Also called by the statisticians logistic regression.

The data tells you the price paid. The in-store observation tells you what is on display, there are features which appear, and with coupons, in the Sunday supplements. So you have a number of control variables that potentially influence the customer. And you have the stream of purchases which the customer made.

This is now a famous paper, because Bob Klein got out and got to the data first and Peter wrote it up, and Peter and I published it. It's a very heavily cited paper, because everybody saw that this was something that they could do.

I mean, many other academics and other databases became available. And people saw that this was a sandbox that they could play in. And they made variations. But there's something called the Guadagni-Little Loyalty Model, which is very hard to beat in terms of forecasting ahead. And I have always said, I've never seen multiple regression do anything like this in terms of its ability to forecast.

It exists today, and people still work over some of these problems. And there are new technologies out there to deal with it. But it's all Marketing Science. It's all Marketing Science. But marketing is a practical subject. And you're trying to do somebody some good. But you need the underlying behavior in order to do that.

ROBERT KLEIN: So UPC data was really "Big Data" in the '80s. And it was an order of magnitude more information than we had, or orders of magnitude more information than we had from just store shipments or store sales alone, because we had it down to the individual family level.

JOHN LITTLE: Right.

ROBERT KLEIN: And you created a system called CoverStory that helped, essentially, interpret that data

automatically.

JOHN LITTLE: Right. And the guinea pig client was Ocean Spray cranberries, which was an MDS client, and had databases readily available. But what I was trying to do is to write a report about significant events that were occurring in the data. And so somebody didn't have to sit down and scan everything, put it on a screen and inspect it. This would be done automatically, and with the highlights picked out.

And so we had a bunch of words which are descriptive of the products, and connecting words like "and" and "is" and things. We wrote plug-in sentences. It was a huge WordPerfect program by one of the authors of this paper.

And it was pretty useful. It has since been overtaken by natural language programming and other good stuff. But this was an early exercise in automated analysis and was appreciated by the people who used it.

It was also had the compliment of a competitive company [which] copied it, essentially, giving it a different name. But that's fine. But I think it was another step toward automated analysis - you had sort of this year versus last year plots automatedly put out, particularly for products that had some significant changes.

ROBERT KLEIN: So you mentioned before that MDS was acquired by or merged into IRI--

JOHN LITTLE: That's right.

ROBERT KLEIN: --in the mid-'80s. And I know you were involved in a lot of the meetings around the creation of InfoScan, which was the--

JOHN LITTLE: Oh, yes. Right.

ROBERT KLEIN: --first giant UPC database now with national data.

JOHN LITTLE: That's right. And my former student, Len Lodish, and another former student, Magid Abraham, were authors of a paper, which I guess was InfoScan, or PROMOTIONSCAN.

ROBERT KLEIN: PROMOTIONSCAN, I think it was.

JOHN LITTLE: But it was a published paper by two of my former doctoral students. Which I used to-- I used to use it. And for a long time, I taught a marketing models class. And that was a section of it.

ROBERT KLEIN: So you went from sort of the small company to the big company. IRI was, I think, the fourth largest market research company in the world at the time they acquired us.

JOHN LITTLE: Right. And then, I was on the Board of Directors, and you have Board of Directors issues. Things like how are we doing this quarter? Not Marketing Science.

ROBERT KLEIN: Not Marketing Science. So what have you been doing more recently?

JOHN LITTLE: Well, I've returned to Little's law. Little's law started popping up, oh, I don't know, maybe 15 years ago. And by then, it was called Little's law, not $L=\lambda w$. And I've had a lot of fun.

The issue, it's been picked up, particularly in operations management. I was approached to write a chapter. I said, well, I haven't looked at this for 40 years. A chapter in a book. I got Steve Graves to help me with the OM.

I think we should come back into a different interview about that. But it continues to go on. I've organized a session at the next San Francisco INFORMS meeting called Applications of Little's Law. There are two or three impressive papers.

One of the issues with Little's law is it applies in so many situations. I mean, queues are everywhere. Things you can think of as queues are everywhere, such as production systems, and things like that.

ROBERT KLEIN: Well, and you mentioned once to me the applications in computer chip design.

JOHN LITTLE: Oh, yes. Oh, yes. Well, I have, if you wish, a sequel to my 1961 paper 19-- oh, 2011, excuse me. 2011 is the 50th anniversary. And so I was asked whether I would like to write a paper, a retrospective paper. And I said, yes. And that's published in Operations Research.

There are many fields - Health Management. There are many queues inside the computer itself. And so the computer designers are very interested in these issues.

ROBERT KLEIN: You want to talk about Betty and your family?

JOHN LITTLE: Yeah. Just a quick-- my late wife, Elizabeth A. Little, was a physicist, as I've mentioned before. We've had four children. Each of them has been either an engineer or a scientist. But I wanted to say something about her attitudes, because she got a PhD - she finished slightly before me - But we both graduated, essentially, in 1955 at the graduation then.

And what I wanted to say was, people often come up to me and say, well, it must have been very difficult being a woman in the early '50s in a PhD program. I disagree. Her parents, or her father at least, was a very successful Long Island doctor who grew up in Vermont. As was frequently true in that family, his wife asked Betty, are you sure it's physics you want? And Betty said, yes. And went on in physics.

Well, I mean, we were there together in the physics PhD program. She was working very, very hard, because some of the courses that I had flunked, she had to pass. But there was a physics qualifying exam and then a general exam. I never heard her complain about any of these things.

She knew what she wanted to do and was doing it. She had plenty of boyfriends. I fought them off. So that's what I wanted to say, because I don't think that she felt any hardship. And let me tell you the sequel, because she is-- really interested in research in Nantucket, because there's no laboratory. Or I was in the Army and things like that. She drifted away from physics.

But she became interested in Northeastern Indian archeology, of which -- Nantucket is loaded with this stuff. She published her own series of papers. She went and got a master's degree at UMass Amherst under what I call the reigning queen of, at the time, of the Indian archeology.

And she knew something about-- well, there's a lot of stuff done by radiocarbon dating. And she was totally comfortable with that, and reading the papers and writing the papers. And so she has a whole series of-- she has co-authored a paper for me. We tried co-authoring when we were in graduate school. Didn't work. Different mentalities. Anyway, but we finally did a co-authored paper for the Journal of Archaeological Science.

And she came to me one day and she said, isn't there is some way I can process this data? I've made radiocarbon dates in all of these specimens, and I've done this for the plants. And she used to go out and collect plants that are native to the region, and shellfish, and things like that. And she says, I have these readings, and I want to say something about the diet. I don't have too many readings. And I said, well-- I mean, the diet could be deer. The diet could be quahogs. I mean, what have you. And I said, well, you could put bounds on these things by linear programming. And she says, well, tell me more.

So I wrote a linear program in EXPRESS. And I processed her data. She made me be lead author. Because she said, if there are any questions about linear programming, she wants somebody who can answer them. But she was a really good researcher, whatever she

touched.

ROBERT KLEIN: And then your kids.

JOHN LITTLE: Oh, our kids. Well.

ROBERT KLEIN: Jack is the founder of MathWorks.

JOHN LITTLE: Yeah, Jack is the CEO of MathWorks.

ROBERT KLEIN: Impressive accomplishment.

JOHN LITTLE: Right. He was an undergraduate EE at MIT, and has a master's degree from Stanford. And then got into systems control issues. But then he saw an opportunity in the PC as a tool for engineering calculations and systems control signal processing. So he went out and got a top notch numerical analyst, Cleve Moler. And conceived-- he was also a good writer -my father complimented him on his writing of his manuals. But they went to a system of toolboxes where they let anybody use MATLAB to create, say, a signal processing toolbox.

So they could easily expand and get more talent for royalties, basically. It's been very successful.

ROBERT KLEIN: Anything about your other kids.

JOHN LITTLE: Sarah-- all my children have two children -- so I have eight grandchildren. Sarah did an undergraduate physics degree at Stanford, and then joined the Woods Hole MIT program. She went down in Alvin. And I tease her-- she now lives in Wellesley. And I tease her, when you were in Perth on a post-doc, I could go see the world. But you're in Wellesley. I've seen Wellesley.

But anyway, she's fine and she works on environmental issues. And Tom is the non-MIT in the crowd. He went to RPI. He's tremendous energy. He formed a company. He was active in the management of the company, and sold the company, and is back at BU where he's in the computer engineering department. He writes papers. He has one which has quotes in his own paper next to my Little's law paper.

And then Ruel, the youngest, is a solar engineer. He has an undergraduate degree from Johns Hopkins and a master's degree from MIT in the-- I don't know, it's the solar engineering crowd is where he is. He was in a startup. And they had a lot of good business-- they probably

still do-- off the grid in California where they grow marijuana. [LAUGHS] Anyway, so that's my crowd.

ROBERT KLEIN: So I think to sort of wrap things up, and I don't know how to do the "how would you like to be remembered?"

JOHN LITTLE: Do you want me to start over?

ROBERT KLEIN: Yeah, right.

JOHN LITTLE: No, but I'll tell you. I have to be remembered for Little's law, which I should do a better job of explaining. And the other thing is that, I think, being in on the early years of marketing science is a satisfaction.

ROBERT KLEIN: There's an article in the Sloan magazine, or sort of that-- in the early '80s that highlighted MDS-- Management Decision Systems.

JOHN LITTLE: Oh, yes. Yes, yes.

ROBERT KLEIN: And it had the picture of all the MIT grads on the stairway and so on. I think MDS is really something that I know I want to be remembered for. And I think I considered you a real role model. And sometimes I wonder, if I had ever gotten a PhD, would that have set me off in just some completely different path?

But I'm so glad that we had the opportunity to work together at MDS, and that I was really focused on working with companies, and that we were always working with companies to come up with ideas that--

JOHN LITTLE: Well, you're still doing it. And that's good. But, well, I'm not finished yet.

ROBERT KLEIN: No, me either.

[LAUGHTER]

So I guess that wraps up at least this segment of John Little's history in operations research.

JOHN LITTLE: Yeah. OK.

ROBERT KLEIN: Thanks.