1. Early Life

ED KAPLAN: Hello. It's November 14th, 2016. My name is Ed Kaplan, and I'm here interviewing Dick Larson. We'll get a more formal introduction in a moment, but for posterity everyone should know that this interview is taking place just after one of the most shocking events in modern United States history. And I, of course, refer to the Patriots loss yesterday to the Seattle Seahawks.

Are you together enough, Dick, to go through with this?

DICK LARSON: I'm still very traumatized. It might take me two or three weeks to recover.

ED KAPLAN: OK. Well-- so now that our viewers understand the historical significance of the timing of this interview, let's proceed. So Richard Larson is the Mitsui Professor in the Institute for Data, Systems, and Society at MIT. He's also the founding director of MIT's Center for Engineering System Fundamentals. And we're going to learn much more about Dick's early life, his education, his career, and his hopes and fears for the field of operations research.

And I'm going to let Dick do most of the talking here. But Dick, this is really going to be a lot of fun. So let's get started. Can you tell us a little bit about where you were born, where you grew up?

DICK LARSON: OK. We're going back into several centuries ago. I was born in Bayside, Queens, New York. Lived there for five years, then my parents-- we all moved to a place in Pennsylvania-- in the middle of Pennsylvania-- called Sunbury, Pennsylvania. It's kind of like in farmland-- very, very nice-- and lived there for six years. Then we moved to North Plainfield, New Jersey. I lived there for five years, and I graduated in the Boston area from Needham High School.

And at age 18, I entered MIT. And they haven't figured out how to kick me out yet. So I'm an MIT lifer, as they say.

ED KAPLAN: He's an MIT lifer. So let's take a step back and then get back to that in just a moment. So you moved around a lot when you were young. So what does that say about your parents' professions? Were they military people? Were they working for companies getting shuffled around? What was the story?

DICK LARSON: Well, sometimes my friends will say, well, when the FBI caught up to your dad did they-- did you move to a different state? And no, but he was an electrical engineer in management. And the whole sequences for-- he worked for Hazeltine which was a defense contractor in Long Island. And then went for Westinghouse, and he ran the radio and TV section for a while.

And then the radio and TV-- their plant moved and got very big in New Jersey, so he moved-- he was an assistant manager of that plant. And then Japan decided they wanted to create TVs and

Westinghouse went out of the business, and then he worked for Raytheon up here. So his path was similar to many people his age who were electrical engineering.

They are promoted into management, and so they would spend anywhere from five to 15 years at a particular job and then move on. So that's how that worked.

ED KAPLAN: OK.

DICK LARSON: The FBI had nothing to do with it.

ED KAPLAN: The FBI had nothing to do with it. And was your mom a stay at home mom, or--

DICK LARSON: Mom was a stay at home mom, and a very excellent mother.

ED KAPLAN: That's wonderful because it takes a lot to look after not only you, but also your siblings.

DICK LARSON: Right, two younger sisters. Yeah. They're great.

ED KAPLAN: And what are their names?

DICK LARSON: Linda and Laura-Lee.

ED KAPLAN: Linda and Laura-Lee. So that's a lot of L's in the Larson household.

DICK LARSON: It is, yeah.

ED KAPLAN: OK, so that's great. So you had mentioned that you ended up in Needham, and that's where you went through high school. That's public high school there?

DICK LARSON: Public high school, the junior and senior year only. And one of my fondest memories of that was I was a soda jerk in the afternoon for three and a half hours every day-- Monday through Saturday-- Monday through Friday-- and it was kind of like being a bartender at a bar with no alcohol, and you got to meet the local folks, and the regulars, and it was a very nice socializing event which was, I think, needed for teenagers at that time.

ED KAPLAN: Needed to need them.

DICK LARSON: Need them, right. Right.

ED KAPLAN: I think that's also perhaps a precursor to your OR adventures because you became an early expert at blending problems, right? OK. So now at age 18, you said you entered MIT. And so what was your undergraduate major?

DICK LARSON: Well let me say something, too, about Needham High School and entering MIT. I owe entering MIT to Sputnik because the Russians put Sputnik into space around 1956 or so, and that caused great alarm in the US scientific community.

And they decided they needed to educate young people-- in terms of physics, and science, and engineering-- differently than the handbook kind of engineering they had before World War II where engineers were viewed as not so contributory as they should have been. And so MIT, and Zacharias, and some others created something called PSSC Physics, and I was in the first class that ever had PSSC Physics.

I fell in love with it. I read 12 books during the summer to even get into the class at Needham High School. And because of that, they had the first ever PSSC Physics test-- the afternoon test-- and I guess I did well enough to-- that's what probably got me into MIT.

ED KAPLAN: I see.

DICK LARSON: So I owe Sputnik to get into MIT, and Zacharias and his other physics professors at MIT who created this new course and fundamental thinking about the physical world.

ED KAPLAN: That's-- so physics really turned you on, then, at an early age?

DICK LARSON: Yeah. And if you think about operations research-- maybe this is going forward in your interview-- operations research, in the late '30s and early '40s, was invented by physicists. So I view operations research as physics applied to the world in which we live in on a day to day basis. I view it as a branch of physics, not of mathematics.

2. MIT Undergraduate and Graduate Years

ED KAPLAN: Very interesting. We will come back to that. But when you actually got to MIT as an undergraduate-- so I was just going back to this-- did you have a declared major at the time, or did you just sort of morph somewhere? Morph into engineering, morph--

DICK LARSON: Well I didn't really know what I wanted to do there, so I asked my fraternity brothers-- I lived in a fraternity for four years, couldn't have gotten through MIT without the support of the upper classmen in the fraternity. It was really, really great-- and the self-learning that we did in small groups of our freshmen and sophomores. And I said, well, what do you do here if you don't know what you want to major in?

And they said, Dick, the best major at MIT for those who don't know what do they want to major in is electrical engineering. So I thought, well, my father would be proud of me if I did that. So that's how I got that.

ED KAPLAN: Interesting. OK. So I wouldn't say it was by default, but it was really more through the encouragement of your support group than coming in and saying I want to be an engineer.

DICK LARSON: Absolutely.

ED KAPLAN: And it also wasn't the case that even-- in spite of the fact that you loved physics coming up, it wasn't clear to you that you wanted to be a physicist, per se.

DICK LARSON: Correct.

ED KAPLAN: OK. So now the year you actually arrived at MIT is what now? 1961, are we talking?

DICK LARSON: 1961.

ED KAPLAN: 1961. OK. And so now you go through your undergraduate career, but suddenly you come out as an operations research student, I believe, as a master's student. So something happened in between there, and I believe it involves grand theft larceny or some other video game like that? What happened?

DICK LARSON: You're abusing my last name. Larson and larceny are quite different. No, but, what happened there is I took four years of electrical engineering-- I did OK in it. I had a summer job creating circuits once for a major large company, and that was fun and interesting-- and they implemented it across the country-- but I didn't like the culture. So I said, I'm not going to do that again.

Then next summer I had a job at what now is called CSAIL at MIT. It was called Project Mac at the time, and I was programming things for three dimensional tic-tac-toe. And I didn't like the culture there because all my colleagues-- when they're awake and when they were asleep were uncorrelated with the rotation of the Earth. So I didn't like that.

So when I went into graduate school I said, well, what do I do? I got all this engineering stuff and math stuff. And so I went through the MIT bulletin-- the catalog-- and the only thing I couldn't dismiss was operations research. I didn't know what it was, I didn't understand what they were talking about, but I said I should try that because everything else I could-- I said I didn't want to do. And I fell in love with it.

It's physics applied to the real world that we-- in which we live.

ED KAPLAN: So this was now-- so 1965?

DICK LARSON: Correct-- 1965. So I started as a master's student in operations research, and then a grand larceny occurred.

ED KAPLAN: OK. So just before we get to grand larceny, we-- so now we have Dick entering the operations research program in 1965. How was it set up at that time? Was it a center, a department? And who were the key people who were running the show?

DICK LARSON: It was a center, and a Professor Phillip M. Morse-- the founder of operations research in the United States, a physicist-- was the director of the Operations Research Center. And Alvin W. Drake-- a professor of electrical engineering-- was my adviser. And the number of students that they had there was less than 20-- roughly equal, I think, between master's and PhD students.

ED KAPLAN: And where there-- I mean--

DICK LARSON: It was a set up as a center-- as an interdepartmental, interschool center.

ED KAPLAN: Right. But how many other faculty were participating at this time?

DICK LARSON: The number of faculty participating was less-- was less than the fingers and thumbs of my two hands. But I don't-- I can't say whether it was six, or eight, or something like this.

ED KAPLAN: Right. So this was really still-- I guess I shouldn't say in its infancy, but it was clearly in a very young stages.

DICK LARSON: It was before-- just approaching adolescence, maybe.

3. Grand Theft Larceny and Urban Operations Research

ED KAPLAN: Just approaching adolescence. OK. All right. So now, about this grand theft larceny, what happened? And what year are we in, again?

DICK LARSON: We're in that same year because about the same time I declared to be operations research--

ED KAPLAN: So '65 again? Something like that?

DICK LARSON: Yeah, in September. So right at the beginning of the fall semester, this thing happened to me. Eric Cosman who was a fraternity brother of mine and a mentor-- he was a physics professor at MIT, so you might say the two of us are really kind of weird here because we went to a mixer at our fraternity to see how the undergraduates were doing.

They brought in some young ladies from Wellesley and some other places. Eric and I looked at each other and we said, there's no gender balance here. There are too many males, not enough females, and we want everyone to have a good time. You know, they were dancing, there was music, et cetera. So we took Eric Cosman's sports car out to the Back Bay in Boston. And, shall we say, that we found two gender balanced contributors to follow us in their car to follow us back to this place.

And they were there for a while, but we were on this living room on the second floor and they excused themselves and they didn't-- you know, bio break or whatever-- and they didn't come

back. And eventually, we went downstairs. We saw their car driving away, and we thought they must have been bored with this party.

At 2:00 in the morning, I got a phone call from the fraternity-- I was there in my Back Bay apartment at the time-- Dick, we think the two young ladies you brought here stole all the cash, and credit cards, and IDs that the other women left in the powder room.

ED KAPLAN: Oh, no. Oh, no.

DICK LARSON: So I felt terrible. And so for the following two months, I learned everything I could do about solving crimes. I borrowed lots of books from MIT library. I followed every lead that they gave us. One of them said they were a student at such and such a college in Boston. I went to the president's office there and said that one of your students left a very expensive gold watch at our party on Friday.

If you could show me the pictures of your students, I could identify her and give her back her gold watch. So all of this stuff ended in never finding these people, but it got me very much involved with police, crime, criminology, and operations research. And so that's how I stumbled into policing and operations research.

ED KAPLAN: So this is interesting. At what point did you-- did it sort of gel on you-- or maybe it wasn't just a sudden thing, maybe it was just a gradual transition that what you were dealing with actually was a series of operational problems.

DICK LARSON: Well, Professor Al Drake saw me walking down the hallway one day with eight books under my arm. He says, Dick, what are those books. I said, well they're all criminology books and policing. He said what, and I had to explain the story to him. He says, OK, I'm registering you now for a 12 unit special studies course. You're going to do research in this, write me a report, and we're going to get-- we're going to bring operations research into this.

And I blame him, but I credit him. I mean-- I mean by I blame him, I put it in quotes-- you know. So he noticed that difference-- that linkage-- and from that came my master's thesis, my PhD thesis--

ED KAPLAN: Lanchester book.

DICK LARSON: --and things in Washington, DC. All kinds of stuff.

ED KAPLAN: Wow. So just one more question on the linkage side. So I know that Al and others were involved in analysis of public systems at the time, and I'm wondering-- was this adventure in policing really the first of these topics, or were there some other things going on trying to apply operations research to public sector systems before it had really turned into a thing?

DICK LARSON: Yeah. Well I always-- Al Drake was very interested in public sector operations research, and he was a key editor in a book that came out from MIT Press around that time. So

there was healthcare, policing, and a number of public sector things. But there's another Al in my life-- I had two major early mentors-- and that's Al Blumstein.

ED KAPLAN: Sure.

DICK LARSON: Is that later on in your questions, or should I get to that now?

ED KAPLAN: Go ahead.

DICK LARSON: Yeah. So, Al Blumstein was then assigned-- it turned out that there was a President's Commission on Law Enforcement and Administration of Justice.

ED KAPLAN: Just quickly remember. When was that?

DICK LARSON: This was the summer of 1966.

ED KAPLAN: Summer of 1966. All right. So we're five years into MIT, one year into your master's program.

DICK LARSON: Correct. And so the President's Crime Commission, as it was called-- Lyndon Johnson's President's Crime Commission-- looked around. They had a-- they had a commission-- they had a sub-commission on police, sub-commission on courts, on probation and corrections and said, hey, we're in the 20th century. We should have a commission-- a part of this science and technology.

So they went to Institute for Defense Analyses in Arlington, Virginia. Al Blumstein was, then, a key researcher there of operations research. And so he agreed to sign up, so he had a staff it up and he didn't know anybody with an operations research assistance background that had any knowledge of policing and criminal justice. So in a desperation, he calls Philip Morris at MIT and says, do you know of anybody?

And he said, well, we just happen to have this young student here who's been involved with policing now for nine months as a result of something he got involved in-- without any details. And so, therefore, I became the youngest member of the President's Crime Commission.

ED KAPLAN: Wow. OK. So what happened with the Crime Commission? Was it just a question of sort of sitting around talking about stuff? Did you actually involve yourselves in actual analyses? Did you--

DICK LARSON: We did a lot of analyses, wrote lots of reports, visited police departments and criminal justice agencies around the country, and I probably spent two and half to three years working with them part time in the summertime, and then also part time during the school year.

ED KAPLAN: How did the criminology people who were involved in this commission react to having someone from such a strong engineering background doing this kind of work? Did they

understand what was going on, or did you just happen to have the right people on the commission?

DICK LARSON: Well our task force was science and technology.

ED KAPLAN: OK.

DICK LARSON: So, for instance, Saul Gass was a member of our task force.

ED KAPLAN: There you go.

DICK LARSON: Yeah. So we had some pretty good operations researchers, a couple of physicists, systems analysis. So we operated in that domain, and then reporting to the criminologists-- we did that at separate meetings.

ED KAPLAN: Right. So we're going to go on with your life in OR and how that developed overall, but I just wanted to stop for a second and ask a counterfactual question. Have you ever thought where you would have ended up, or what you would have ended up doing, if that grand theft hadn't occurred?

DICK LARSON: You know, if I knew who those two women were, and if they were alive today, I'd take them out to dinner because they changed my life for the positive. And I reflected on that, I learned something. I thought, you know, everything that happens in life happens for a reason, and a lot of things that happen you think originally are negative you can turn into a positive. And a lot of my operations research career and the things I've done research in all stem from personal experiences.

None as traumatic as that one, but some personal experiences I reflect on them and say, gee, you know, that's really important. We haven't really considered that in operations research, let's bring that into play here. So, yeah. If that hadn't happened, I don't know. Maybe I'd be selling used cars right now somewhere. Who knows what I'd be doing?

ED KAPLAN: There's another lesson to be learned, though, which is that while you can imagine experiences like this happening to many people, not all of them are going to actually have the wherewithal to recognize that there's a there there beyond the event itself.

And that's what I think is so interesting about your story-- that you were able to not only-- originally, you're trying to solve the problem of who stole-- who stole the goodies, but actually turned it into something, you know, there's a much, much bigger picture here and, in some sense, this just pulled the cover off this whole other world for you.

DICK LARSON: It did. And operations research is one of the few-- maybe the only-- profession where you can make such linkages because if you view operations research broadly, it applies to almost everything. And so therefore, there's always an operations research approach to a particular problem. That's the beauty of it. So if you have a career in operations research, you're

not 50 years on designing circuits or you're not 50 years on creating the most efficient code for an optimization problem.

You can spend two years on this, five years on that, you can multi task so at any given time you're working on three or four different things at the same time, and it's extremely exciting. I'm still just as excited about it today as I was when I started.

ED KAPLAN: So let's go back, then, to when you were heavily involved-- now as a PhD student you're still working, I gather, with Al Drake in the main as your adviser.

DICK LARSON: Al Drake and Al Blumstein in DC.

ED KAPLAN: And Al Blumstein in DC. Were there others at MIT who are really part of this, or was that most of the guidance you were receiving?

DICK LARSON: That's most of the guidance I was-- that was 90% of the guidance I was receiving.

ED KAPLAN: Had you already reached out and made links to some other-- I mean there were certainly some other operations research is in the same generation with you-- the Jan Chaiken, Warren Walkers, some of the folks in New York City--

DICK LARSON: Yeah, that--

ED KAPLAN: --but that really came later.

DICK LARSON: That came a little bit later with the New York City RAND Institute. And that came, I think, in 1968 or so. So there's a transition there, yeah.

4. Applications in Policing

DICK LARSON: And by that time, I had-- just about finishing my PhD thesis, which then resulted in a book called *Urban Police Patrol Analysis*. And, yeah, so that's how that all played out.

ED KAPLAN: Right. And *Urban Police Patrol Analysis*-- 1972, MIT Press, youngest Lanchester prize winner, I believe, to date for INFORMS. That's one record which still stands, as far as I know. One question I have is that I remembered Jan Chaiken wrote a review of that book in the New York-- *New York Times*, actually, in a book review.

And, you know, he was describing the problems you were working on, but he also mentioned it was chock full of mathematical equations-- that was the one phrase that I remember. And actually, it is chock full of mathematical equations because, of course, when I was a beginning graduate student that was one of the first books that I read.

And what struck me was the trade off between getting involved in the details of the problem and the rigors of analysis-- because certainly you solved a lot of interesting problems, but you went beyond that. You would look at models like round off errors, and one way streets, and all sorts of things which really were beautiful problems in probability, beautiful problems in networks.

But, of course, all motivated by the work that came out of policing. So I'm wondering if you could say something about the relationship between the application and the important sort of policing problems on the one hand, but also the feedback to developing new models and new methodology which then went off and sort of had implications for all kinds of other things.

DICK LARSON: That's--

ED KAPLAN: It's a mouthful, I know.

DICK LARSON: That's a long question. Yeah. On the one hand, I must have-- I know I spent hundreds of hours in police departments-- monitoring them. Not monitoring them, but observing. Some of these were in the backseats of police patrol cars. I know we'd go by certain high crime areas and they thought they nabbed that guy, they arrested that one-- that was a bad guy.

And so this was both in New York City and Boston area, but both police departments were very cooperative. And I also spent about half that time in dispatch centers where they were taking calls. 911 was not available yet, so they were, like, seven digit phone calls. In New York City, I remember, you had to know what section of the city you were in. They had more than five-- they had seven different numbers to call police.

If it's Manhattan, you had whether you were Manhattan north or Manhattan south-- same about Brooklyn. And so I was there on day one when the first 911 system was installed in New York City. And at that time, I was a consultant for the New York City RAND Institute. But as I did this and I looked it, I could figure out the spatial aspects, response times.

And the police cars had to travel by the right angle metric and the Manhattan metric in Manhattan, or the spaghetti metric in Boston. You know what they say-- they let all these cows out of the Commons and they followed each one to create a street. And so I fell in love with geometrical probability. So I probably went a little bit overboard with some of the geometrical probability stuff because I found it beautiful mathematics, intuitively appealing, and sometimes giving surprising results.

So maybe I threw a lot of that into the *Urban Police Patrol Analysis* book and-- yeah. About that time, the New York City RAND Institute was being formed because the RAND-- the RAND Corporation from California, which is one of the birthplaces of many techniques of operations research-- it was fantastic-- born, like, I said, in the 1940s late after World War II.

RAND, I believe, stands for Research ANd Development, and it was funded initially by the Air Force-- and still a lot of Air Force work there, but now they're much more general. And so for seven years, the New York City RAND Institute operated out of New York City, and I was very privileged to play a major role in that.

ED KAPLAN: So actually, if I just go through the different techniques in the *Urban Police Patrol Analysis* book for a second, because I think it's really quite interesting. People, of course, will think of it as applications for policing. But you start with stochastic modeling and geometrical probability, as you mentioned. There's also networks. There's also optimization and dynamic programming. Maybe you could just say a few words about that?

DICK LARSON: Yeah. Well, dynamic programming is my favorite OR algorithm because it's so intuitive and so useful. And dynamic programming can apply to, for instance, scheduling of dispatchers to scheduling of police cars. And it's not one of these things where you have, you know, one objective function with, you know, 75 terms and then 200 linear constraints-- it's very, very intuitive.

And at that time, that's all you really needed for the kind of police applications I was looking for. So it just fit very, very naturally into that. So, you're right. I try to pull in these techniques as they were needed, but I didn't try to pull in something just for the sake of it.

ED KAPLAN: No, not for the sake of it.

DICK LARSON: Even the geometric probability stuff, you know. I was interested in, OK, if we switch from all two way streets to one way streets how-- what's the penalty involved? Or, if you can make u-turns versus not making u-turns. And some of the results were counter-intuitive to me.

ED KAPLAN: Or even if you take a look at different limits. If you throw out the street pattern all the way and just go to spatial Poisson, for example-- that kind of thing. I remember one of the papers-- I don't think this is part of the policing book, but work with Keith Stevenson on insensitivities in location theory.

DICK LARSON: That work was derived from our work with the New York City RAND Institute.

ED KAPLAN: Right. So maybe you could say a little bit more about it. What happened here was, instead of solving optimal location problems the idea was-- suppose you were able to simply randomly locate your facilities as opposed to put them down optimized on a sort of rotated square pattern, something of that nature.

DICK LARSON: You've really done your homework here.

ED KAPLAN: Well, thank you very much. But the question here was basically how much error would you get because what it takes to solve the optimization is very, very difficult. What it takes to throw things down at random is not.

DICK LARSON: Right. So I've used-- the random thing, you know, you basically throw darts at the map of the city-- whether it's Manhattan, or Brooklyn, or Boston-- and you throw darts. And you're not very good at aiming so that once they hit the map, that's where you're going to locate facilities, or ambulances, or police, or whatever-- versus an optimal location.

And typically, the maximum improvement you could get, if I recall correctly-- it's been a while since I looked at this-- is about 25% or so. And I found that variation small. And it's the issue of the insensitivity-- if you're in the region and if you're more or less OK with your locations, don't worry about six decimal accuracy because it's-- the minimum is very, very, very, very flat.

And so we learned a lot about that, and actually that helped New York City with its ambulance locations because in New York City, the ambulance location can be out on the streets. Doesn't have to be in a fire station, or by a hospital. All they have to do is paint part of the curbside red and that can be a home location for an ambulance. And so that helped a lot with our model that we developed with RAND-- so called Hypercube Queueing Model.

ED KAPLAN: Which we're getting to very soon.

DICK LARSON: OK.

5. Applications to Other Urban Services

ED KAPLAN: We'll leap into hyperspace in a moment, but what I wanted to just speak a little bit about with you now was-- and actually I remember this because this is now right about the time that I entered MIT, so I date us at 1977-- which was that these techniques which you had developed in the policing world obviously had a lot of application for other urban services, too.

And similarly, there were other researchers at New York City RAND who were working on problems in fire, fire develop deployment, and emergency medical services, and so on. With Amedeo Odoni, you pulled a lot of these results together into *Urban Operations Research*, which has become, I think, the classic text in that field. I wonder if you could just tell us a little bit about how that came about, and the interplay between working on the book and teaching the course which went with it.

DICK LARSON: Yeah. We still teach this course today, so it's over 40 years old-- or young-- *Urban Operations Research*. And we use the word urban, but it really-- people who are not going to deal directly with cities and who have other issues with applying operations research with the real world also benefit from it.

Now Amedeo Odoni shares one thing with me-- we're kind of like brothers. He was born one month after I was born-- we won't say what century or what year-- and he entered MIT the same September that I did in 1961, and he became an assistant professor in the same September that I became one. So we're both MIT lifers. And so we became really, really good friends and colleagues.

And we learned that we viewed the world more or less the same way-- very compatible-- and so we decided to write this book. And he brought a lot of stuff that he had been doing-- particularly in air traffic control, and queueing and these sorts of things-- and I brought the urban police patrol analysis, and also some of the stuff that we've done for the New York City RAND Institute, and put it together into that book.

ED KAPLAN: Right. And the book is now available-- I think it's available online. And it's also been reprinted, right?

DICK LARSON: It's been reprinted, so you can buy the reprint or you can get it for free-- the original Prentice Hall version.

ED KAPLAN: One page at a time

--on the web. So just do a Google search, urban operations research, it'll take you right to the original Prentice Hall version.

6. Hypercube Queueing Model

ED KAPLAN: Now I want to ask just a few more questions about some of the methodological work you did, and then I want to work backwards between the relation or the positioning, say, of this type of work versus what was going on in the rest of operations research at the time. But let's start, first, with a few more of your own contributions. So the word hypercube came up. So could you just remind us a little bit of what that was, and where it came from, and why it was so important?

DICK LARSON: Yeah. Well queueing became a really important issue in emergency-- urban emergency services. I'll go back to 911. When 911 was announced by Mayor Lindsay, I believe-- I'm not quite sure, but I think it was Mayor Lindsay at the time-- and it was-- New York City was the first one to have 911. So seven digit numbers collapsed to one three digit number, which was phenomenal.

And so they implemented it, and it worked. But then all of a sudden, within a week or two, you saw letters to the editor of the *New York Times*, the *Daily News*-- Dear editor or dear mayor, I called your 911 line on Saturday night. I got 30 minutes of a ringing telephone. I hung up and tried again, after 29 minutes. "911 emergency, may I help you?" And so, they brought me in there as an emergency thing with two lieutenants-- Lieutenants Massini and Carvino.

I wish them well if they ever see this. And so we worked side by side, but basically lived in the police headquarters for a month. Got all the data, looked at it all, and we figured it out. And basically I applied Erlang's queueing formulas to this because the police department didn't know about that, and their allocation of operators was such that we had the utilization factor rho strictly greater than 1 by a significant amount on weekend evenings. Unbelievable.

So we published that-- that's published in Al Drake's book on urban-- on public sector--

ED KAPLAN: Public systems, right?

DICK LARSON: Public systems analysis, yeah. And so then I said, well, we have to apply queueing also to police cars, and ambulances, and fire trucks. How do we do that? Well, the Erlang M/M/c model assumes that all the servers are clones. They're statistically all identical,

you can't see any distinction one from the other. But out in the real world, and in a spatially distributed queueing system, they're not clones.

You might have one ambulance-- let's say ambulance X-- that's in a relatively sparsely populated area and might have to travel miles to get to a scene, whereas you have another ambulance which is at a very dense area, highly populated, but might only have to drive half a mile to get to the scene on average. And so therefore, the service times would be different, the service times could depend on utilization factor because they become busier.

They have to travel further to back up people who are already busy. And how do you deal with all this? And then I figured, well, we need a state within a binary state-- 110111-- but ones correspond to a particular server I being busy, zero corresponding to that server I being idle, and you have a hypercube kind of state space. And, to my knowledge, nobody had ever done that before in queueing and so we had try to create that.

Now imagine computers in the '70s-- do Moore's law backwards for a half a century, and the computers were terrible.

ED KAPLAN: Slow.

DICK LARSON: They were very slow. What I'm holding in my hand here, three Cray room size heat generating super computers of the 1970s. OK? So, there you go. So we created the hypercube queueing model, we actually programmed it up with all 2^n states and it worked for n equals up to-- I tested it, n equals 12. Then I think it was New Haven, Connecticut who called me.

"We'd like to use your hypercube queueing model, Professor Larson." "Terrific. How many police cars do you have?" "Well, we have 42." "OK. How many districts are they in?" So I can think of the independent queues and apply it to-- because New York City, like, had 72 different precincts or something like this. "Oh. We all operate together as one system." 2 to the 42 didn't work.

So then we generated-- we wrote a paper on approximating the hypercube queueing model, and I ran the two of them in parallel for two years. And never did I see the approximation more than 2% off from the exact. And so that's how that came about.

7. Queueing Theory

ED KAPLAN: That's great, and picking up on the queueing theme-- of course, you also have an alter ego of Dr. Queue. And so outside of the urban services area, but just in general, you have a love affair with queueing theory, which has gone on forever. And you've also made contributions independently of the urban services work in queueing, probably most notable among those is the Queue Inference Engine. So maybe you can tell us a little bit-- how you became Dr. Queue.

Why queueing as opposed to other particular methods? And how did the Queue Inference Engine come about?

DICK LARSON: Well, thank you for that. So we're now leaping forward to the late '80s.

ED KAPLAN: Late '80s.

DICK LARSON: And, again, I have to say-- just like the incident with the fraternity and the mixer, almost every one of my operations research problems was started by a personal experience. So I didn't go to the journals and say, oh, I see 10 papers on this. Maybe I could write the 11th. It was usually a personal experience. So in this case, the personal experience was I happened to have an NSF research grant on queueing. Now how did I get that?

Well, I didn't just sit down and say, oh, I want to write an NSF research grant on queueing. What happened is I had a personal experience-- my son Eric was 6 years old, and my son Evan was like 2, and Ingrid wasn't born yet. And so we went to a large box store, which I will not name, to get a first bicycle for my son Eric. And what happened from there-- I picked out-- they had two colors. I picked up red, more exciting.

I paid for it-- they said, go back to the warehouse part there and give your ticket, looked like a pari-mutuel betting window for a horse racing place, and I saw a woman hysterically crying. So I went over to comfort her and said, "What's wrong?" "I've been here for 40 minutes and people have come and gone, they got their thing, and I still don't have my thing."

So I comforted her. So soon later, she got whatever she bought. And all of a sudden, I was there for a half an hour or 35 minutes. My poor family was out in the car thinking I would quickly come back with this thing-- with the bicycle. And finally, the bicycle shows up and I bring it in a box to the car. And my wife says, "Well, what happened to you? We thought you'd be here much faster. It's late for dinner, and the kids-- the kids are tired."

I said, "Well, I will never, ever patronize that store again. This will be returned unopened on Saturday. We'll go to a nice bike store." So I was furious that violation of first-come first-serve many times over in this queueing situation. And three weeks later, I was still angry. So I started asking other people-- "Do you ever have experiences like that?" "Yes." "Have you ever made a lifetime pledge never ever to patronize that place again?" "Yes."

So I thought, OK, I'm going to get even with them. I'm going to write a proposal to NSF to research this.

ED KAPLAN: That'll show them.

DICK LARSON: And NSF funded me. So I was doing queueing research, so that's how I got involved with the psychology of queueing-- personal experience. So then Baybanks of New England-- which has now been purchased by Bank of Boston, which was then purchased by Bank of America-- but they had a nice ATM network around Boston. They said, "Professor Larson we hear you're going to do research on queueing."

We need some help from you to determine whether we need more ATM locations, or in the ATM locations we have if we have the right number. And do we have the right mix? Because

right now, we're bringing in limited function machines where you can't deposit. And there was one that cost one-third as much as the full function machines where you can deposit. And so, can you help us?" And so that's how that started.

And I said, "Well, I need some data. You have to give me data, otherwise I don't know how to handle this." And then I didn't hear from them for four months. I forgot about it. Four months later, a truck shows up and brings in, like, four old fashioned paper computer printouts, put it on my desk, each of them was like this. And each one had like 200-- each page had like 200 ATM transactions.

And so then I had thousands of ATM transactions and I said, "Why did it take you four months?" They hired interns to manually black ink out the ID number of the customers. I'm thinking, why couldn't they have programmed that and just do a special run? But they didn't. So that gave rise to the Queue Inference Engine because I looked at this-- I was just going to write them a quick little report using Erlang's formulas to show them how Erlang applied to this and that was it.

And then all of a sudden I realized, I can figure out by inspection which people were delayed at queue at an ATM and which ones were not. And how long the queue busy period was because, you know, when you put a card in the machine and then when the card comes out, if there's somebody behind you, the next card goes in very quickly. If there's nobody behind you when the card comes out, then there might be five minutes until the next card comes in.

That person experienced no queueing delay, and the next 13 people in that busy period did. So I could separate out by inspection the people who were delayed in queue and the busy periods. And then I thought, well, is there something more here? Can I do something rather than Erlang's formulas? And I realized the order statistics applied to the Poisson process when you know during a particular period of time n people showed up.

But here we have a sequence of embedded constraints-- that you know the first person has to show up before the first person-- the first customer left there, and the second, et cetera, et cetera. So you have a bunch of nested inequality constraints, and I just applied that. And the net result was the Queue Inference Engine. Which, when I programmed that up and ran it, was extremely accurate in terms of predicting the queue performance not only of the population of people, but each of the customers themselves.

So we wrote up several papers about it. But one of them I said, you know, when you get your bank statement every month in the mail it's possible that a bank could actually say, oh, and here are your ATM queueing performance for this month as well.

ED KAPLAN: Here's how long you waited.

DICK LARSON: As far as I know, no bank has taken that up yet, but they could.

ED KAPLAN: That's really interesting.

DICK LARSON: I'm sorry to be so long winded on that. But again, I wanted to indicate how personal experiences can be brought into operations research.

ED KAPLAN: On time performance for ATM machines. Granted, I want to step back a little bit because all of the examples that you've talked about. They have been problem driven. They've all been based on real experiences. None of them have involved off the shelf methodology. They've all involved new modeling and, in some cases, new mathematical insights just from working on this.

8. Perspectives on Operations Research

ED KAPLAN: Now, at the same time you're doing this there's all the rest of what's going on in operations research. And I'm just wondering how you would-- I don't want to say compare and contrast, but in some sense how do you situate it? I mean, you know, what-- if you were going to divide the OR world up into two or three clusters, say, how did it look to you at the time you were doing the work?

DICK LARSON: Well, I don't know if I actually asked myself that question. But I have been involved with ORSA first, where I was president once. And then INFORMS, and-- so I've been involved with the profession for my whole career. And, you know, I note-- I noted by the historians, this is before my time, that of the original members of ORSA in the 1950s 50% of them were social scientists. And the rest were a combination of physicists, engineers, and mathematicians.

And apparently, within the first decade, the social scientists were pushed out and made to feel unwelcome. And my observation is that operations research, as a profession-- first of all, I believe it's the world's most important invisible profession, operations research, because we have so much that we can offer to the world in terms of improving things. The profession has become too insular, and we have too many folks in the profession.

I don't know if this is getting the answer to your question, but we have too many folks in the profession who just enjoy talking to each other. It's almost as if we speak our own language. Here we are at this convention-- which has maybe 5,000 attendees, very impressive, from all around the world. But we publish in our journals, and I think INFORMS has about, what, 15 journals? Something like that? 14, 15, journals which are highly respected.

But people who make decisions-- congressmen, senators, voters-- you know, John Q. Average American, or China, or Russia, or whatever country-- they don't read our journals, and so we really need to get the word out-- particularly for things that are impactful in our day-to-day lives. And I wish more operations researchers would do that. There's a little bit too much emphasis on, oh, I'd like to reduce 0.1% from this optimization algorithm.

If I can just shave it by 1.1%, I get my name on-- the guy who did that. And, you know, that might be worth six days of Moore's Law in the generation of computers, and really of no consequence in real life. So I'll just share one more thing. Sometimes I'm invited to go to

universities and give inspirational talks to PhD students, and typically I might say-- toward the end of the talk I say, well, OK imagine you're launching your career now.

You're going to choose some things to do research on, obviously you want to publish your thesis. But when you get a chance to decide what your next research thing is going to be, would you rather write the 999th paper on a topic first formulated in 1948? Or would you rather write the ***first*** paper in an area that you formulate, realizing there's a probability there'll never be a second one?

90% of them prefer to write the 999th paper in a topic first identified in 1948. I find that very depressing. We operations researchers need to take risks. We need to take more risks because we are the world's most important invisible profession. And if we can apply OR in some out-of-the-box applications which are important to society, we can have major, major impacts.

And somehow, I think we've lost that in the battle for getting tenure, and promotion, and getting published in our premier journals of operations research and management science-- which are basically now vehicles for tenure and promotion. So somehow we need to change the objective function, and incentives and reward structures a little bit to be more outreaching.

ED KAPLAN: Right. OK. So that brings us into your time as president of ORSA-- and back into your time as president of ORSA-- and then, of course, several years later. I guess, what? 10 years, 20 years later, when you were president of INFORMS. So can you tell us just a little bit about what it was like when you were ORSA president or what was happening at the time? What was some of the most exciting stuff?

And then maybe tell us a little bit about how ORSA and TIMS turned into INFORMS from your point of view.

DICK LARSON: Well, in terms of ORSA-- by the way, I'm not the only person who feels the way I just talked about. There's a small cadre of folks in the profession who feel that we should be more outreach, and how do we market ourselves. And if I recall correctly, was this-- was this a Science of Better, or was that INFORMS? I can't recall.

ED KAPLAN: That's INFORMS.

DICK LARSON: That was later on.

OK. But with ORSA, I think I was the last full term president because they were getting ready to create INFORMS. And so that was very, very exciting because management science-- TIMS, the Institute of Management of Science and Operations Research Society of America would have co-terminous meetings. Conferences like this one.

Their councils would meet in adjacent rooms, and then they'd have a joint meeting, and the whole thing didn't make any sense because they were basically brothers and sisters and they were in the same family. So it made so much sense to merge and get going, and I think it's an example-- a huge success example-- of one plus one equals five.

So it was great. Now the journals are fantastic, they have high impact factors-- most of them are very well-respected around the world-- and so-- and there's no profession-- there's no professional society I'm aware of elsewhere in the world that comes close to what INFORMS does in operations research, management science.

And actually, if you look at the 14 or 15 journals, there are some like Marketing Science and Organizational Science which are really a little bit outside the center of operations research and management science and which are well-respected in their own right. So I think that was very exciting to be involved with that. And with INFORMS, that was the Science of Better. I think you used to call it the Science of Butter.

ED KAPLAN: Right.

DICK LARSON: Or the Science of a Batter, if it's baseball. I mean, we made all kinds of puns. By the way, he's a great punster. And so that was very exciting, then, too. And if I can say another personal experience-- because at this time, again, people wanted to get outreach. They wanted to explain to the world what operations research does, so it might have been Irv Lustig. Were you involved with the actually videotaping of some of us?

And some of us actually gave little video talks where we're talking to the general American population. So I was supposed to be the queueing guy. So, if I recall correctly, I was in a studio. It might have been Baltimore. There was a meeting in Baltimore. That rings a bell. I was in Baltimore at one of these meetings, and they videotaped me the first time and then they said "Too boring."

So I tried it again. "Still boring." So then I said, OK, I am Dr. Queue. I am Dr. Queue, and I have an audience of 35 out there asking me questions, and I'm going to answer those questions. And so that video, which is still on the web-- look up Larson, Dr. Queue-- still on the web, it's from that INFORMS meeting, and I was absolutely out of my mind.

And people say, "I didn't know you had an audience out there. You pointed to these people." I said, "Yeah, that's the way it was." And that gave me that second identity which, if you do a Google search on Larson Dr. Queue, you get lots of hits. And it's not something that I try to deliberately perpetuate, but it's a self-fulfilling prophecy with Google because if any media person calls me and writes a story on radio or TV, then it goes on Google again, then the Google thing gets even richer.

And so that is perpetuated to this day.

ED KAPLAN: My favorite one is running across the rope bridge in Japan or something.

DICK LARSON: Oh, yeah.

9. Education Initiatives

ED KAPLAN: But let me ask one or two new questions here, which is-- you have become very, very passionate about the importance of education. And in particular, education in technical fields. Early, early education-- high school or early university-- and in developing nations. And so you have your initiatives at MIT, and BLOSSOMS and LINC. I'm wondering if you just tell us just a little bit about the initiatives, and why you're so passionate about it.

DICK LARSON: LINC is Learning International Networks Consortium. We started it in 2002, and the idea was to reach out to the developing world and share best practices in technology enabled education to give good educational opportunities for young people who ordinarily wouldn't have them. Their local schools aren't so good, et cetera, et cetera. You might notice that 2002 is the year after 2001. That's not a coincidence.

And we've got a lot of people at MIT volunteers as a passion to do this to reach out, and more than half of our foreign LINC membership, initially, was from the Middle East. And we actually then ran six LINC conferences-- the largest one was 600 people. The patronage of Her Majesty Queen Rania in Jordan was in 2007, and that was located also in Dubai-- and the son of the ruler of Dubai was the patron there.

And so we now have-- at a typical LINC conference, we have 50 countries. 300 people come and they share best practices in technology enabled education, focused on the developing world. And I'm happy to report that this past year, MIT-- from the President on down-- has signed up to owning LINC going forward-- I've depersonalized it.

And in spring of this year, MIT ran the ***first*** LINC conference and they promised to offer a LINC conference every other year in perpetuity, alternating between an MIT site and a foreign site. So we're very, very happy about that. In 2007 or 2008, we started BLOSSOMS-- *Blended Learning Open Source Science Or Math Studies*-- that was LINC's major initiative.

We're now in year nine of BLOSSOMS. We have 11 country partners, 11 languages, and we're creating interactive videos to be shown by the teacher in high school math, science, and engineering classes. And fundamental principles, and to create critical thinking skills, appreciation for other cultures, excitement about STEM careers, showing relevance of STEM in everyday lives.

And because we get a lot of dropouts of young people who could really contribute to STEM and get a lot of teenage dropouts-- differentially, females-- and so I'm happy to say that more than half of our BLOSSOMs-- maybe about half our BLOSSOM classes are done by females. As role models, but they're excellent teachers. And we have students, we have professors, we have other workers.

And so I'm very passionate about it. And I know we're just about running out of time, but I should say there's a huge opportunity for operations research in technology enabled education-- huge-- and so we're just getting into that right now.

10. MIT's Institute for Data, Systems and Society

ED KAPLAN: That's great. I do have just one or two more questions that I hope we can get through here. So you are in a new position at MIT in the program-- Institute for-- I've got to remember what it is.

DICK LARSON: The Institute for-- Data, Systems, and Society.

ED KAPLAN: IDSS.

DICK LARSON: IDSS.

ED KAPLAN: Of course, before that you were the director of the MIT operations research. I think you did multiple stints at that.

DICK LARSON: Two stints at that.

ED KAPLAN: That's multiple. Anyway. And, of course, you have many children and grandchildren in the academic sense out there. Many doctoral students and-- oh, well, OK. And I'm just wondering if you-- do you know, actually, how many we-- do you keep count of these things? How many doctoral students do you have?

DICK LARSON: No. I've lost count. I've lost count.

ED KAPLAN: You've lost count.

DICK LARSON: It's over 30 doctoral students, and they have-- they begat doctoral students and they-- so I have children, great grandchildren, great, great grandchildren, and there might be another great there somewhere. But they're all great.

ED KAPLAN: No unwanted children. How are you finding this new home at MIT now? Can you tell us a little bit about IDSS and how it compares to the operations research center?

DICK LARSON: I think it's too young and too early-- we're still in year one. We just entered the first doctoral cadre-- there's no doctoral thesis selected yet, so it's still early. But if you think about the name-- Institute for Data, Systems, and Society-- that's a brilliant name because 90% of the problems of the world would fall under that umbrella.

So if the professors and students in IDSS view the diameter of that umbrella broadly rather than narrowly, I think it could be a huge success and have a lot of impact. Exactly how it compares and contrasts with the Operations Research Center, we do not know. The initial design of it-- where I wrote a five page memo proposing this design-- included the Operations Research Center as part of it.

And for a variety of reasons, that hasn't come to pass. So at the moment, we have these two things that are going-- maybe they'll be like TIMS and ORSA. And maybe somewhere down the line, they will merge. I would be greatly in favor of that.

11. Legacy

ED KAPLAN: Interesting. All right. And I guess I'd like to close with-- and I mean this-- I mean this in a nice way, which is-- if you think about your own legacy, you've been a member of this field for so long. You've been a leader in the field for so long, you've generated many students produced articles, books-- people know you. You've had many different experiences.

How do you want to be remembered inside our field yourself? That guy Larson, he was-- fill in your blank.

DICK LARSON: Well, I want to be remembered joyfully. So people want to remember me as Dr. Queue, I'm happy with that. If people want to remember me as contributing to urban emergency services, that's fine.

But I think more generally, the idea of taking operations research-- here's a person who could take operations research broadly, big umbrella diameter, and then issues, and problems, and things would happen in his life and he brought those things into-- under the operations research umbrella, and helped create new models, looked at data, made inferences, and contributed to then how those things could be improved in the real world.

And so that tying up to the real world, and to modeling, and the methods-- to me, that's the foundation of operations research. That's how the original physicists, included Philip M. Morse-- who created operations research around 1940 or so in the US and in Great Britain, that was in response to the war effort-- that's how they viewed it.

And so I'd like to be remembered as somebody who followed in that kind of tradition.

ED KAPLAN: I think we're at the end of our time. Dick, thank you very much.

DICK LARSON: Thank you, Ed.

ED KAPLAN: Peanuts in the shell.

DICK LARSON: Peanuts in the shell.

ED KAPLAN: Great. All right.

DICK LARSON: He's great.

ED KAPLAN: Thank you. Thank you very much.