An Interview with

PAUL A. STRASSMANN

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Conducted by Arthur L. Norberg

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Abstract

After briefly describing his early life, Strassmann focuses on his application of electronic data processing technology to statistical business problems. He discusses his engineering education at Cooper Union, and his work with Howard, Needles, Tamman & Bergendoff in turnpike construction. Strassmann highlights his work on the New Jersey Turnpike and his traffic flow analysis of the turnpike in his Sloan School thesis, "Forecasting of Turnpike Traffic and Scheduling of Toll Collection Personnel." He then describes his work in cost analysis and profit accounting with Burns and Roe. Strassmann concludes the interview with a description of his work in plant and inventory control management for General Foods including his decision to contract the firm's computing work to C-E-I-R rather than purchase computers from International Business Machines.

PAUL A. STRASSMANN INTERVIEW

DATE: 15 May 1987 INTERVIEWER: Arthur

LOCATION: New Canaan, CT

NORBERG: Today is May 15, 1987. I'm in the home of Mr. Paul A. Strassmann for an interview on various application developments with respect to his activities in information processing at companies such as Kraft and General Foods. Can we start at the beginning? Can you tell me a little bit about your family background -- particularly your date of birth and location?

STRASSMANN: I'm Paul Strassmann. I was born on January 24, 1929, in a small town, Tunchien, in Czechoslovakia. In 1938, being of Jewish origin, we were put under extremely difficult circumstances. And in 1944, after my father and my entire family were sent to a concentration camp, I managed to escape and at the age of 15 became a noncommissioned officer in the underground, with a distinguished long record of terrorist attacks on German freight trains.

NORBERG: Had you had any education in Czechoslovakia before 1938?

STRASSMANN: I had just elementary and junior high school education until 1938, but I had no education in the intervening war period. I came to the United States in 1948, a week before the communist takeover, because the underground that I was involved in was the anti-communist... It was the western, the London-sponsored underground and the entire leadership of that anti-Nazi underground got purged. My friends suggested that I may be better off to leave, and since I didn't have any family or any attachments, I was free on a moment's notice to walk out of the country.

NORBERG: Did any of your family survive the concentration camp?

STRASSMANN: Nobody survives. I came to the United States in 1948 and I lived for two years at a home of a friend

of my father's. And after two years I was able to earn enough money working nights and weekends for an engineering firm, Howard, Needles, Tammen and Bergondoff, to be able to support myself.

NORBERG: How had you come to get this position, if you had no educational background?

STRASSMANN: When I arrived in the United States, since I always wanted to be an engineer since I was a small child, I went to the Jewish aid agency, HIAS, and asked how I could get education. They pointed out to me that education was hard to get and that engineering was not a recommended profession in 1948. But there was this school around the corner from Lafayette Street, downtown New York, which was accepting very talented young people with no tuition whatsoever. And that was the only school in the United States that had no tuition. I walked in to the admissions office of the school, who suggested that I sit for an SAT examination. They waived the fee. They paid the fee for me. I apparently got accepted. I was the last before the cutoff score, coming in largely not because of my verbal -- my english was very poor, but because of mathematical [skills]. The admission test for engineering school in those days was heavily oriented towards spacial relationships.

As you know, in those days, they had three dots like this and then they rotated the dots and say, "Is A like B?" And apparently I knew how to do that. I got a perfect score. And the admission officer brought me in. I must say, I graduated second in the engineering school. Four years later, to the dismay of the admissions officer, he pointed out that he always had very high correlations between the SAT admissions and the follow-up performance tests. But he never had somebody who came in last that came in second at the end. (laugh)

NORBERG: Now, the name of this school was the Cooper Union?

STRASSMANN: Cooper Union. The Cooper Union was founded in 1860 by a very wealthy merchant by the name of Peter Cooper -- who also was the mayor of the city of New York, who felt that indigent young people of talent should be

able to get an education. So he took a piece of land -- on which, by the way, the Chrysler Building stands today. He owned that entire part of New York north of 42nd street. And this school, to this day, is being supported from that endowment.

NORBERG: What sort of a program did they have?

STRASSMANN: They had a program in engineering; mechanical, civil, electrical and chemical engineering; and an art school. They took every year, a hundred students into engineering and a hundred students into architecture and arts.

NORBERG: What sort of courses were offered? Do you remember the courses in, say, electrical engineering, civil engineering?

STRASSMANN: Well, the electrical engineering course was oversubscribed. So I ended up in the course which was the lesser choice: civil engineering. It was a full-fledged curriculum in structural analysis and engineering design and physics and mathematics. The Cooper Union is very highly rated as an engineering school.

NORBERG: Do you remember any of your classmates?

STRASSMANN: Oh yes.

NORBERG: Can you talk about a few of them?

STRASSMANN: Well; Ron Mayrbaurl, who was number one in the class.

NORBERG: Could you spell that last name for me, please?

STRASSMANN: M-A-Y-R-B-A-U-R-L. He is the expert today on bridge failure in the world. He gets called in when highway bridges collapse and auditoriums collapse and what have you. He's an expert on flat plate design. There is a physicist by the name of Zacharias.

NORBERG: At MIT?

STRASSMANN: No, a different Zacharias, who did the early work, also at MIT, on vacuum tubes. There is a guy by the name of Ralph Cooper, who is a physicist. There are others like Fred Schnagle, who ended up with the investment bank of Lazard Freres. People are in various walks of life. There are others who have fairly mundane careers. I sort of keep in touch with them. And of course, the dearest schoolmate of mine is a wife of mine; because we got to know one another during student days.

NORBERG: Which curriculum was she in?

STRASSMANN: She was in art. I was the dumb engineer (laugh) and she had all the cultural aspiration. She was going to reform this dumb engineer. By the way, there was a tremendous amount of cross-marriage in Cooper Union between the art school and the engineering school.

NORBERG: Now, you would have been there between the years, 1948 and '52?

STRASSMANN: I entered Cooper Union in 1949; in September of 1949. And I graduated Tau Beta Pi, cum laude, in May of 1953.

NORBERG: 1953. In the meantime, you were working for this engineering company.

STRASSMANN: In the meantime, I was working for the engineering firm. And as I was doing extremely well in engineering, I quickly came to recognize that I did not have enough education, particularly due to a lack of any liberal arts background or history background. So, in my senior year I competed for admission to MIT. They had just opened the Sloan School, which was a graduate school in industrial management for engineers who would want to have much broader interests. And I was accepted, one of 22, into the full opening class of that school. The Sloan School existed before, but the graduate school only opened, actually, late in 1952. And I let it be known at Howard, Needles that I would not be coming back to work for them in September, because I was going to go back to MIT.

NORBERG: Let me ask you a couple of questions, first of all, before we proceed. The full name of the engineering firm was Howard, Needles...

STRASSMANN: Howard, Needles, Tammen, Bergondoff, a Kansas City firm, by the way. They came east in order to partake from the great expansion in bridgework associated with toll road construction, which was booming in those days.

NORBERG: That was my second question to you. What sort of engineering was this company involved in?

STRASSMANN: This was structural engineering.

NORBERG: How did you come to work for them?

STRASSMANN: Just blind. I was looking at the end of my sophomore year for a summer job and they needed somebody to go out into the woods of West Virginia to help with surveying and laying out the lines for what subsequently became the West Virginia Turnpike. So I spent my sophomore year making an incredible amount of money. In those days, $1200 was an incredible amount of money a month, working overtime, traipsing through the backwoods in the

hollows of the country behind the Canava River, killing rattlesnakes and stuff like that.

NORBERG: Now, you worked for this company then, for what...?

STRASSMANN: I worked for the company right through 1955. I worked for that company from 1950 through 1955.

NORBERG: You've mentioned the surveying activities. What happened the following summer, before your junior year?

STRASSMANN: The following summer I was on the New Jersey Turnpike, because that was going through a tremendous amount of muck outside of Bayonne. By that time, I was promoted. I was chief of the party that was doing drilling for subsurface rock determination. As a matter of fact, it was a fairly responsible position, because subsequently when you were putting foundations in, you had to know whether you put it on rock or whether you put it on a boulder. Otherwise the piles would slip. The drillers needed continuous supervision, because they were removing soil samples from up to 120 to 140 feet below the surface and these samples had to be sufficiently undisturbed and carefully preserved so that there would be an audit trail and a proper diagnostic of what was pulled out. Then, of course, you had to change from clay drilling into rock drilling to make sure that you were in bedrock. So I had about two or three drill rigs. I was what's called, by that time, a junior supervising engineer. I was running back and forth between these drilling rigs. As they were pulling the casing, I was always present at the opening of the casing, measuring the soil, looking for samples, looking for evidence, and writing an engineering report. Then the next summer I did that on the main turnpike, which was very tricky because that's going through blue clay and glaciated moraines and the bedrock is striated, which means finding where the footing should be. It gets very, very tricky.

NORBERG: Now, had you been prepared for this sort of an investigation through your studies at the Cooper Union?

STRASSMANN: Yes. It was a very practical school. The school had very poor facilities, but by virtue of the Darwinian

selection that they practiced... They always looked for very hardworking, young people from the New York area, from Brooklyn, so the school was really made by the fact that the student was extremely competitive, perhaps overcompetitive. It was a very practically orientated kind of empiric, no-nonsense kind of work. The [same is true of the] engineering firm of Howard, Needles, since I was willing to put in long hours on my lab notebook. The soil samples looked very good and their checking revealed that I was able to deal with the drillers, who were a rough lot, by the way. They all came from an Indian reservation down in Georgia. These are very arcane stories, but, due to my combat experience, I guess I was able to keep up with those guys, and went out drinking with them, and so forth. That's conducive to good engineering, by the way.

NORBERG: What is? Going out drinking?

STRASSMANN: Oh, yes. With the drillers, sure.

NORBERG: Why?

STRASSMANN: Well, because the drillers generally try to fake their way, because they get paid by the foot. So if they can just ram the casing down without really caring too much about the sample, you don't get good samples. Of course, you're out in the woods with these guys. If you come from, sort of, innocent suburbs of Queens of New York, the so-called office engineers can easily be sort of pressured and bull-dozed into accepting samples, because after all, those are the natural conditions. There's a great deal of judgement in sampling, subsurface sampling. So you sort of have to be very hard-nosed about that kind of an environment.

NORBERG: Would you be taking samples from the surface down, or...?

STRASSMANN: From the surface down, oh, yes. The typical sampling process consists of a benchmark that you

establish at the sampling site. Then you set up a rig and you start driving a casing through the surface layer of soil. It's a casing, a steel casing, four inches in diameter. And through the casing, you then flush out the soil. And it's put in an auger, which has a flap at the bottom, bring in a sample, bring it out, you open it. And then you lay it into boxes, which have little slots. And then you put little labels in there. It's a very interesting kind of a process -- subsurface exploration. It's fairly primitive. A great deal depends on it, because lots of bridge failures are due to abutment failures. And usually it's very hard to find a good combination of a good engineer and a good driller who really comes up with the evidence of what's going on.

NORBERG: Is there any statistical analysis done of the distribution of samples?

STRASSMANN: Oh, yes. Oh, you have to do statistical because what happens is if you are not satisfied that you got a good sample, which could be due to water pressure problems, it can be due to a cave-in. I mean, there's zillions of things that can happen. You have to make an on-site decision to pull the casing and start anew. In those days, it went at $6 a linear foot. And when you got into rock it was $12 a linear foot. So the money mounts very rapidly. And of course, the engineers in the home office want to always design stuff, you know. Of course, what they do is they take this totally imperfect information and then can go through very complicated, (hardy cross), moment equations to compute to the nearest decimal point the moment distribution on the boot of the footing, which of course, is meaningless, if you don't have all the samples ? And so you really have to have a feel about validity of data, the distortion in the data gathering process. Come to think of it, Arthur, it's an excellent training for gathering data, and learning the discipline in management, and in computers, and in going and talking to people about project planning, which I did not know it prepared me for.

NORBERG: Well, this is what I was sensing from what you told me earlier, before we turned the tape recorder on. And what I've learned from other of your writings. Now, was this statistical analysis very sophisticated?

STRASSMANN: No, because basically what you have to do is you have to take your sample, take a big quadrille piece of paper, put it in and eyeball it. And then if the thing, sort of, is consistent... You see, when you drive piles, plus or minus two feet doesn't make a difference. And so if the rock ledge at which you are going to put the footing is sort of within reasonable contour -- fine. Once in a while, of course, there may have been a creek, so you have, suddenly, a discontinuity. And the statistical analysis doesn't help you. You almost have to visualize the geology of the place. But you know, in Maine, I sunk a couple of hundred holes. So you sort of get a feel after awhile.

NORBERG: In Maine, did you say?

STRASSMANN: In Maine; on the Maine turnpike.

NORBERG: Now, this is the first time you've introduced the subject of the Maine Turnpike.

STRASSMANN: Well, no. You asked me what I did the third summer. The first summer was West Virginia. The second summer was the New Jersey Turnpike. The third summer was the Maine Turnpike.

NORBERG: I see. Okay. I missed the Maine Turnpike. Now, it was around this time that the problem with the New Jersey Turnpike toll booth situation first came up.

STRASSMANN: Well, then I came back to the New York office in the summer of 1953, now a full-fledged engineer with a degree. Of course, Howard, Needles wanted to keep me. I started attracting the attention of the partners. Of course, it was a firm with over 400 engineers. So this was not an itty-bitty firm. This was one of the more prominent firms. And one day, I remember, it must have been July or August, I know I was sweating, because the ozilid prints had these pink marks from my arms -- the whole drafting room smelled from sweat and ozilid paper. I don't know whether you have any experiences with...

NORBERG: Well, I found it in records of various companies. So, yes, I've seen the ozilid paper.

STRASSMANN: So I was sitting there. And Timby, who was the senior managing partner, comes by. And he says, "Strassmann, I understand that you are going to MIT and you are studying management. How are you going...?"

NORBERG: Before, you told me that he asked you what you were going to study.

STRASSMANN: No. "... Are you going to study statistics?" And I said, "Well, yes. I'm going to study statistics." "Well, we have this new project and it's on the New Jersey Turnpike. We have just completed and opened the New Jersey Turnpike and there is a problem with the toll booths. There is a dispute whether the toll booths are overmanned or undermanned. And I need somebody like you to go and help me out with this project." In short, the New Jersey Turnpike Authority, which was a separate authority from the state of New Jersey, apparently was being questioned by the governor, who maintained that whenever he drove on the turnpike -- which, by the way, was usually off rush hour, which, of course, immediately gives you a biased sample -- there are idle toll collectors there. On the other hand, the union, which apparently was largely composed of families, Italian families, who sort of tried to find employment for the various members of their family on the turnpike, which was considered a cushy job, by the way; a well-paid cushy job. So that they were overworked. And so the question that was posed to the designers of the toll booths, the engineers who designed the physics of the toll booth, was to find out whether there were too many or too few toll collectors.

NORBERG: Can we go back to just one other question there? How had the decision of how many toll booths there ought to be (that's very poorly worded)... How had the decision been made to construct a certain number of toll booths at each collection point?

STRASSMANN: Well, when the New Jersey Turnpike was built, traffic volumes were estimated. And I had access to those numbers. They were average rates based on experience with the George Washington Bridge and the Holland Tunnel, which were extrapolated. At each interchange, enough land was provided that an additional toll booth could be added as traffic changed. So there was a flexibility in the design. The toll booths were made by a company in Brooklyn. They were prefabbed. You know, if there would have been a major misdesign, which, of course, took place within four years, because nobody could anticipate the traffic growth that the New Jersey Turnpike generated. There was company called Taller and Cooper where you could just order one of these toll booths. And they would have installed it, with some grading and so forth, in six months. But the state of engineering design in all of those days was that you basically took averages, wherever you could get the averages. Then you usually applied a safety factor to it. We used to call them "bugger factors". And the safety factor was usually picked by the partner. And the partner said, "Well, whatever you have, multiply by 1.4." And that was the answer. I mean, that was the state of the art. Well, that's engineering. And so Timby comes and I say, "Well, I have to find out more about this problem. Can I go and collect tolls?" And so arrangements were made, including the union had to approve that I would go and stand and inhale smoke and fumes at Interchange 18, which was the George Washington Bridge. In the summer of 1953, most likely in August -- awfully smelly... I don't know whether you know anything about the Passaic River and the swamps. It's awful. I collected tolls a couple of days, and I came back and I told Timby, "By gum, we can really do this thing, because I discovered that every vehicle, which, of course, I knew before, but then I could actually see the procedure, every vehicle that got on the turnpike received a Remington Rand card, full card, with round holes. The round holes showed the interchange in the lane where the vehicle entered. So it was precoded. At the exit, the driver hands over cash and the ticket to the toll collector. The toll collector puts the card into a clock which time stamps the number of the exchange, the lane of the exchange, and the time of arrival. It then gets bundled at the end of the shift with the money, and is brought to the New Jersey Turnpike Authority building in New Brunswick, where there were Remington Rand machine sorters, which tallied the cash in the bag against the toll receipts. Basically, these tallies were being used purely for accounting purposes, for audit purposes, no other purposes, no traffic studies at all.

NORBERG: Was a traffic study an acceptable analysis technique at that time?

STRASSMANN: Oh, yes. Traffic studies go back to the twenties. By the way, the leaders in traffic studies were engineers of the New York Port Authority; many theoretical papers on behavior of traffic in front of toll booths were collected by the New York Port Authority and I had access to the data. I immediately got those citations. So I developed a certain amount of confidence that at least we have some understanding of what are traffic flow patterns. So, since I needed money anyway, and Timby at Howard, Needles needed somebody in whom he had confidence that could do the job, we made a deal that Howard, Needles, would make space available for me at the Boston office, in the Tremain building, where I could come in and put in about 20-25 hours a week working this problem, while I was going to MIT.

NORBERG: You reviewed for me before what some of the problems were associated with traffic patterns. Could you go over those again, as to what sorts of differences they were?

STRASSMANN: I think that it's a pattern that repeats itself in my history. I sort of brashly walk into something only to discover later on how complicated things are. In other words, to do things well. And of course, after further studies, I quickly discovered that the problem of scheduling of toll collection personnel was extremely complex. Let me give you some of the variables. First, there is a daily pattern; namely, certain interchanges are commuting exchanges, which means the entrance patterns and the exit patterns change by the time of the day, and by location. Not only is that true by time of the day, it also varies by day of the week, because there is a great deal of shore traffic, which means that there are special override harmonics which get superimposed on weekends, which gets further compounded by holiday traffic, Fourth of July,...

TAPE 1/SIDE 2

STRASSMANN: ... Memorial Day, Christmas holidays, Mother's Day, and so forth. There is calendarization both daily

and weekly. Then they have monthly patterns, of course, because traffic is seasonal due to the nature of that environment. And lastly, of course, you had a secular growth trend that, meanwhile, the presence of the turnpike starting generating developments. That means that each interchange at any given hourly point had its own unique harmonics, which was totally independent. And so it was a time series problem, a complex time series problem. So that's on the input side.

NORBERG: You also mentioned something about behavioral patterns.

STRASSMANN: That's the same problem.

NORBERG: I see.

STRASSMANN: The first determinate, of course, is how much traffic there is. The second determinate is how you serve that traffic. And it turned out that also wasn't simple, because there were two grades of collectors. There was a senior collector, who had certain administrative tasks, and then there were junior collectors, who did not have administrative tasks, which means their duty cycle, or the time that they had available for collecting, was different. Also, the configuration of the toll booth was such that the lanes were that sometimes you had left-hand cash and right-hand cash. This was before every driver was accessible to a toll collector. At the time, when the turnpike was constructed, in order to save money, there were lanes where the person sitting next to the driver could only hand over the cash, which complicated the thing. So what happened is that the configuration of the exchange in the way the booth, left-hand and right-hand booth was located affected the collection rate. Also the intake rate, at those times there were no automatic

dispensing machines for either collecting cash, or for giving out a ticket. So the through-put rate for both entrances and exits was different. And you could not mix entrances and exits on certain exchanges, because of the separation of lanes; although in the small rural exchanges, at low traffic hours during the night, you could open the window on specially constructed toll booths, so that a single server could serve both entrance and exits. Then, there were union rules as to time off. And there were union rules as to relief, because you could not have a single toll collector there at an exchange booth for security reasons, as well, because of relief. Then there were different patterns in through-put rates, because when the traffic got very low, in other words, when the traffic decreased below a certain critical level, the through-put rate decreased very rapidly, because nobody was pressured. Also the arrival rates, Poisson arrival rates, were such that you did not have enough time to do the serving. On the other hand, when queues build up, the drivers had time to prepare change. Also, the through-put rates varied depending whether you handled motor vehicles, or automobiles, or trucks, particularly multiple-axle tracks took much longer to process in certain exchanges, like the Elizabeth exchange, which was a truck terminal, was heavily track loaded. Also, there was a geometric bias. When you look at an exchange you came out of it -- in those days the New Jersey Turnpike was still two-lane -- when you came out of two lanes, everybody favored the right hand booth, which means that the Poisson distribution on the right-hand booth was different than on the left-hand booth, which means you couldn't get the through-put rate even if you wanted to. I think of other complications. I have a long list. But clearly, this was not a simple problem.

NORBERG: Yes. Now, have other people identified these aspects, say, on the New York Throughway, or were you the first to uncover these, to your knowledge?

STRASSMANN: To my knowledge, everybody has written about all sorts of quantitative things, particularly the George Washington Bridge, which had eighteen booths, already identified the problem of geometric bias. The Port Authority also identified the problem of different through-put rates, and so forth. So many of these things were, in fact, known, not quanticized. There was some queuing in theory that was written. [Telephone interruption.] Do you care for shaggy stories like this?

NORBERG: Oh yes. Very definitely.

STRASSMANN: So far as Howard, Needles, Tammen and Bergondoff was concerned; so for as the New Jersey Turnpike Authority, so far as Paul Strassmann was concerned, this was all new, because the methodology until then was... May I now go to exhibits?

NORBERG: Yes. We'll have to identify them carefully so that we can put them together later on.

STRASSMANN: This is my only copy.

NORBERG: Your only copy of...?

STRASSMANN: Of the thesis.

NORBERG: Yes. Okay, so this study was done as a thesis topic at the Sloan School, eventually.

STRASSMANN: Eventually, because I had so little time. I had a brand new wife and I was working for Howard, Needles, and trying to make a passing grade at the Sloan School. I finally convinced my professors, who were very eager for me to do it, because they had very few theses with real data.

NORBERG: Okay. We'll come back to the MIT school.

STRASSMANN: And so they approved very early. You know, I had my thesis topic just very, very early.

NORBERG: What's the full title of it?

STRASSMANN: The full title is "Forecasting of Turnpike Traffic and Scheduling of Toll Collection Personnel."

NORBERG: Done in 1955?

STRASSMANN: The thesis is dated May 15, 1955. The work for this particular thesis, which was theoretical work, was subsequently authorized in July of 1954 as a consulting contract from the executive director of the New Jersey Turnpike Authority to the firm of Howard, Needles, Tammen and Bergondoff, who paid me a consulting wage to do both investigations. Now, this is the thesis, which is a document, which is approximately 80 pages long. It has only summary schedules. In addition to that thesis, there were three volumes of each of over 200 pages, which were the detail computations, which were delivered to the New Jersey Authority. There is one page which shows, which is the summary of the output of the thesis, which is figure 38, which you may want to look at, which is really the key output. It is titled "A Sample of Typical Results of Scheduling Computation Obtained by Means of IBM 403 and IBM 604 Computers." The listing basically is a tab listing showing by year, by month, by day, by hour the number of toll collectors required in a particular site.

NORBERG: That's quite a lot for the first hour. Four. Does it go down as the... Oh, yes, it does. I see. It then begins to build up again.

STRASSMANN: And then it starts building up. And then, of course, it computed the equivalent traffic, which was an adjusted equivalent homogenous... Everything was converted. It did a traffic forecast; an exit traffic and an entry traffic forecast by the hour. It looked at the crewing, both by seniors and juniors of entry collectors and exit collectors. And then, I took into consideration the geometry, to take what is the raw number required to compute the actual crewing. That is resolved with a computation which really goes back to a set of manual computations, which I will be discussing in a

moment, which takes into consideration the coefficients in the equations, which were then loaded into the 604 to do an iterative computation.

NORBERG: It looks to me like there is a problem here. If the Remington Rand cards are being collected on the toll gates...

STRASSMANN: All the Remington Rand cards were converted. Apparently, there was a service bureau somewhere that Frank Verzuh knew about. They did the conversion.

NORBERG: Okay. How many cards did you have to deal with?

STRASSMANN: Well, we did sampling. Of course, what we did ultimately is that there was a population in excess of eight million. And so I did a Monte Carlo sampling of that population. And I believe that the total number of cards was in excess of 200,000.

NORBERG: A reasonable number to deal with and to do the conversion.

STRASSMANN: Yes. I mean there's some discussion as to statistical validity. In fact, there is a discussion, which I did not remember until I looked at it this morning, on the effect of errors, sampling errors. I have here a schedule somewhere, which is... effect of sampling errors. There are some significant innovations in here. I will get to it later on, but somewhere in here there is, in fact, a sensitivity analysis of the validity of the sampling, which was new. It was a statistical innovation, because when I delivered this report to the New Jersey Turnpike Authority, I gave them an estimate of how statistically reliable was this forecast, because we were dealing with the future. The other thing which, of course, was a total innovation was that I did something that had not been done before. In order to do the tradeoff, the economic equilibrium of the tradeoff, I took the user waiting cost and the arrival rates and then the cost of collectors, and I did an

equilibrium, an optimal switching. In other words, the criteria for bringing in additional collectors was when the marginal cost of the queue of the user waiting cost, and I put an imputed value to the user which was reflected in the price differential the user paid for the toll on the New Jersey Turnpike, as compared with the travel on the local congested highway.

NORBERG: That's interesting. I wouldn't have thought of doing it that way.

STRASSMANN: Well, there had to be a price. There had to be an imputed price for waiting.

NORBERG: And, I presume, this would be some sort of an average figure, because for the governor to sit there waiting and for me to sit there waiting is not the same.

STRASSMANN: My point is that I did not want to deal with what is called subjective pricing. I think you found it later in my book. There is no such objective. There is only market price. And the market price is what people pay. And since the toll, anybody who travelled on the New Jersey Turnpike could have also travelled on Route 1, that was the price of time of people on the New Jersey Turnpike.

NORBERG: I see. Now, the price of time... What fraction of time?

STRASSMANN: Well, I had, of course, the queuing algorithm. I had the vehicle arrival rates, and then I had the collector rates, and the user time. Here are my switching times, which are built into the computer. Now I'll show you other goodies in here. The point that I want to make is: the machine was doing computations which were not doable any other way.

NORBERG: Now which machine was making computations?

STRASSMANN: The 604.

NORBERG: This is your problem now, not the turnpike.

STRASSMANN: That's right. In other words, in order to arrive at the schedules of how many collectors were needed. And of course, then I added them up and I looked at their actual schedule. I have exhibits in here which compare how much they actually scheduled, and how I computed they should have scheduled, and so forth.

NORBERG: Was there a comparability between the forecast and the real numbers?

STRASSMANN: Oh, it was tracked. It was tracked, because what we do... You could reinitialize the thing and go back. And say, "Well, let me forecast now in traffic, which I actually know," which is the way I tested the thing; by a forecasting algorithm.

NORBERG: But did you find that less toll collectors were necessary or more at a given location?

STRASSMANN: The answer was that the total number of toll collectors was right. They were mal-distributed.

NORBERG: I see.

STRASSMANN: So it was a distribution issue and a scheduling issue. It was not a...

NORBERG: Now, when we talk about a scheduling issue in this sense, does that mean that, me, as toll collector A -- should I be at the Elizabeth location and then later on I'm going to move to another location.

STRASSMANN: There are limits, because you can only work at certain gates. The union rules prescribe how far these guys can travel.

NORBERG: Between gates?

STRASSMANN: Between gates. So if you are ? on June 7th, and you are just a collector and this is a senior collector, and ? is also section chief so he has some administrative job allowance. And I have to tell you where you're going to be in what shift. And this is first shift, first shift, days off, third shift, third shift, days off, second, second shift, day off, and so forth. Two of these are swing shift, the straddle shift.

NORBERG: But it's only at one location that this person is on duty.

STRASSMANN: In this particular case it was only one location. There were a premium case to be paid for switching.

NORBERG: I see.

STRASSMANN: But it could only be done with a certain distance, because of various families sort of owned a piece of the turnpike. I mean, you have to understand (laugh).

NORBERG: You have to understand New Jersey politics for this. All right, let's go back to the beginning of this problem.

STRASSMANN: And by the way, there are other sorts of normal graphic kind of complexities. But I'm just giving you the flavor.

NORBERG: Yes. I haven't completed the discussion of this yet. I want to approach it now from a slightly different angle. And that is, if we go back to the summer of 1953 when you were first being approached by Timby in connection with this problem, how did you approach MIT about doing this study? Or did it matter to MIT whether you were doing this study or not?

STRASSMANN: Well, I never even thought about MIT. You see, it was just... I said, "Well, I'll do it." It's what is called a "can do" attitude. And it sort of evolved. You know, it's just... I didn't know how many cards I would have to handle. I did not even know there was a thing as a 604 there. You see, I only knew about WHIRLWIND and I knew about the Harvard... the MARK computer.

NORBERG: How did you know about those?

STRASSMANN: Well, in the dorm, I was next door to...

NORBERG: Oh, I see. You were already at MIT?

STRASSMANN: I was in a dorm; the married dorm in the navy barracks behind the glue factory. And next door was Dr. Art Freeman, who is now the head of the physics department at Northwestern. He was working on WHIRLWIND. So he was always coming and telling me about the WHIRLWIND, this and that. I sort of got very fascinated by that. And I remember very early, when I came up to MIT, maybe in the first week, Moni and I went up to Harvard. We sort of walked. It's a nice campus. And there was this low, squat building with a big glass pane. And I said, "What the hell is this?" And it was just full of lights and people were busy. And it looked very terrific. People explained to me this was MARK IV, or something.

NORBERG: Could be by that time.

STRASSMANN: Yes. MARK IV. And I said, "Well, tell me more about it." They said, "Well, look it up in the *Scientific American*." So then I started really reading up on it. And so, as soon as I started looking at the complexity... You see, it took me all year of 1953 to really understand all of the complexities. I mean, there were all kinds of... Originally, I wanted to do it on a Marchant calculator. You see, doing it on a CPC was almost an afterthought, when I numerically just got totally zonked out. You see, I started doing nomographs. Originally, like a good engineer, I constructed scheduling sheets, where the thing was solved momographically. So I had everything done manually. You see, this is normal Sunday from September 15 to January 3 forecasted traffic. Here is the entry which takes into consideration all of the geometry and what have you, and so forth. And then, of course, you did the shifts, the exit traffic time. So I spent most of my time doing the paperwork. And the paper solution, and the structuring, and the testing, and running into dead ends. You know, what's the equilibrium? You know, when do you add another...? When do you shift? And then build up a cost penalty. I spent all of 1953 on that. It's only when I realized that this was totally untractable. I mean, I just would never get it done using a Marchant calculator, that I revisited and started talking to people. And this Frank Verzuh and so forth. That only happened in 1954.

NORBERG: I see. So you now realize that there's another way to do this sort of calculation. Were you consulting with people? Consulting -- I don't mean that in the professional sense, but were you asking people like Verzuh what sort of problems could be solved on these other machines, the CPC, for example?

STRASSMANN: No, I was terribly busy. I just didn't have the time. You know, I was just strictly problem oriented. You know, I'm one of these narrow barrel kind of guys. I sort of barrel in on something. I was only interested in other solutions, although Art Freeman was telling me about nuclear lattices computations and resonances and all of that stuff. He's a solid-state physicist. He's done very good work in cryogenics. I was really interested, and I asked Frank, who helped me, how do I reformat my nomographs? How do I organize the data, because, you see, this machine had only 500

bits of memory; only had 500 tubes. So the question is, in order to do the computations, you had to read in a set of data, do your computation, print the result, and then go to the next batch of data, which means the whole problem had to be restructured from a nomographic solution, which had everything organized, to a totally sequential set of processes. In a nomogram, you have a great deal of latitude of sort of winging things and approximating. There's a whole problem of number truncation and how to get a cross total and so forth. Those things took me months and months to re... I had to totally rethink the problem. The advantage was, however, that I had already solved the problem differently, which means I knew the structure and I knew the typology of the problem. And of course, I had solutions, which means that when the stuff came out of the machine I could compare them.

NORBERG: Let me see if there are some other influences here, in asking you a few other questions about what was going on simultaneously. What was the program of the Sloan School that you had entered?

STRASSMANN: No computers; none whatsoever. In the second year -- it's a two year course, in 1954, Bob Gregory offered an elective. This was the first elective that I know of. It was in the fall. I think it was in the fall, or it could have been in the spring. No. It was in the spring of 1954-1955 academic year. Gregory finally got the powers-to-be to allow him to offer an elective course. There were two students in the elective course.

NORBERG: What was the elective course?

STRASSMANN: On computers. Business applications of computers. There was no lab. There were no machines available to do anything. It was all book work. And there were two students: Ted Manglestorf and myself and Bob Gregory. And the class hardly ever met. We sort of talked. But, you know, Gregory saw what I was doing and he was just very enthusiastic about it. But there was no interest in the Sloan School in the student year of 1954-55 in computers at all.

NORBERG: When you said it was entirely from book, what books? What sort of text material would you people have been using?

STRASSMANN: Gee, mostly articles. There was a book by a guy by the name of Orlitski, I think, available in those days. You know, it was like binary arithmetic and paper tape input. It was purely a hardware description of what some of the early machines were, and lots of lecture notes.

NORBERG: Okay, would it have come from WHIRLWIND, by any chance?

STRASSMANN: No. The Sloan School did not talk to WHIRLWIND. When Forrester switched from WHIRLWIND to Sloan School, it was a disaster! This is the year when he switched, and you know, the Sloan School totally rejected him.

NORBERG: What was the regular program of the Sloan School?

STRASSMANN: Finance, accounting, statistics. I mean, you know, Paul Samuelson was my economics teacher. I had Solon as my statistics teacher. I mean, I had Schultz as a visiting professor.

NORBERG: Schultz, the Secretary of State?

STRASSMANN: Oh, yes. I mean, it was absolutely stellar days.

NORBERG: So the standard sort of business...

STRASSMANN: No, it was an MBA. It was a quantitative MBA course. It was an attempt to do something different

than the Harvard Business School. It was the attempt to bring quantitative analysis to management. That was the underlying idea. And it deteriorated into poor operations research.

NORBERG: We best pursue that. Why do you say deteriorated into poor operations research?

STRASSMANN: Well, because it was all theoretical and it was not empiric. Nobody collected any data. I mean, nobody got mucky with getting data, converting punch cards. I mean, people didn't do that. Operations research people didn't do that. You know, guys like Phil Morse went actually on submarines tenders to actually go and lay depth charges before he decided what the pattern should be. But there were very few OR people. Most of the OR people, in those days, just liked to do desk algorithms.

NORBERG: Even as late as 1955?

STRASSMANN: Oh, sure.

NORBERG: By the time you took this elective with Gregory, had you advanced on the solution of this problem using machinery?

STRASSMANN: Oh, sure. I already knew about sequencers and plugboards and all of that. You know, I was immersed in that.

NORBERG: Was there a CPC at MIT?

STRASSMANN: Oh, yes. In the main building on the second floor. It was in a part of the administration.

NORBERG: How did you get access to it?

STRASSMANN: I guess Frank... I don't know, Frank just said... You know, he got time on it, so that's all right. That machine wasn't used very much. I mean, the admissions office did alumni mailings on it, and stuff like that, accounting stuff.

NORBERG: What was the reaction in the Sloan School to the problem, if they were not interested very much in quantitative analysis? You did mention earlier that there was some excitement about this, because it was a quantitative problem.

STRASSMANN: Yes, well, my thesis advisor, Whitten, and to a larger extreme, Gregory, were very excited about this thing.

NORBERG: Was it presented to the faculty and students at any time?

STRASSMANN: No. I was late with this thing. In other words, this was down to the wire. I delivered this thing a day before it was due. I mean, this was one of these last minute rush... I had so many other things to do.

NORBERG: What other things?

STRASSMANN: Well, you know, I was delivering things for Howard, Needles. I had a wife and my grades were not the best.

NORBERG: The sort of mix of normal living, we're talking about.

STRASSMANN: I was living... You know, I was not at school. I was sort of out in the outside world.

NORBERG: Were you doing other projects, then, for Howard, Needles?

STRASSMANN: Oh, yes.

NORBERG: What other projects?

STRASSMANN: Oh, just some analysis of foundations. They wanted to validate some of the subsurface things with electrical resistivity probes. In other words, you put electrodes into clay and then you read... You have active and passive and the reflective pattern confirms the contour. So I said, "Fine." I think I was getting something like $4 an hour

NORBERG: So during this entire period from 1953 through 1955, you were working essentially half time, or even more for Howard, Needles.

STRASSMANN: Oh, sure.

NORBERG: Still continuing to go to school.

STRASSMANN: Oh, sure. MIT was very expensive. I didn't have a scholarship.

NORBERG: Even in graduate school, it was necessary to work.

TAPE 2/SIDE 1

STRASSMANN: Sorry, I was offered a scholarship. I actually won the scholarship, the so-called Rossi scholarship. And after I received it, I refused it, because I felt I could earn my way, which my wife always has held against me.

NORBERG: As you were coming out of the Sloan School in the middle of 1955, what sort of prospects did you have?

STRASSMANN: Well, I felt that I really ought to go with Howard, Needles because they had been very good to me. And they offered me quite a bit of money. They really wanted me to develop the practice.

NORBERG: Which practice?

STRASSMANN: Statistics, management, traffic flows, and that sort of thing.

NORBERG: Things they had not been doing before.

STRASSMANN: They had not been doing before. That's right. And they were very pleased with me. And I moved back to New York with my wife, who was finishing her master's at NYU. And then she got pregnant and I needed a house and what have you. And Howard, Needles, was unable to develop much business. So I believe I was around from May through October or November, and then I met with a partner and I said, "Well, look. Really, were getting no place." I was doing engineering work, you know. I was back to soils and geological profiles, and I really didn't want to do that. So Timby said, "We're sorry to lose you. We'd love to have you, but I guess you'd better go and look for something else." It was very, very amicable. "And anytime you want to come back, we'll always have you," which is the only way to have a job, by the way.

So I started looking around. And on a totally blind basis, a headhunter told me, "Why don't you and see the president of this engineering firm called Burns and Row." Burns and Row would like to look for somebody who really is both an

engineer and has an understanding of management. I went for this interview in another engineering firm. It had about 500 engineers. It was all New York -- going from power engineering, which was classical power. They built big electric thermal power stations. And I went in for the interview with this guy, a little guy. It turned out he was an ex-Navy commander, who used to be Rickover's side-de-camp. And the guy said, "I'm not going to interview you. Here is a test. Go into that room; and whenever you have an answer to the test, just come back." It turned out that the test was a problem dealing with an engineering situation for which there was no answer. Excuse me.

[INTERRUPTION]

To make the story short, he gave me a problem that was non-deterministic. And he hired me on the spot as assistant to the president.

NORBERG: Why? What was your performance like?

STRASSMANN: I said there was no answer. He said his problem was that a typical engineer would try to force the thing, because engineers are taught to be given a problem and come up with an answer. I became his assistant. Then I became assistant controller. I was given the tabulator installation to run. I was with Burns and Row for four years as assistant controller, member of the executive committee. Then the firm got involved very heavily in defense work, very advanced defense work, ground support equipment and what have you. I couldn't get the secret clearance for whatever reason. So we just had to pass, but I got a great deal of experience with tab equipment, 402s, 406, 602. I totally reformed the company. I mean, I'm still in a very good relationship with Ken Row. His sons are now in the firm. But I set up, basically, a process between project management or tab machines. It was a very early application. Each project became a profit center. You see, until then you couldn't do, really, project profit analysis.

NORBERG: Why not?

STRASSMANN: Well, the accounting system, and the time cards, and the flow of costs was always kept at a very high departmental level. A typical engineering organization in those days was departmental. You know, the electrical department, the drafting department, the design department, and a heavy construction department.

NORBERG: And so when you had some drafting done, it would be paid in that department, and therefore, would not be allocated to a specific project.

STRASSMANN: That's right. And so, the company greatly increased its size. In fact, the experience with Burns and Row goes back to my whole notion of profit center rather than cost center. The notion that the project becomes a P&L, a profit and loss center. It becomes mission oriented. It becomes goal-driven rather than bureaucracy driven. So some of the very early thinking about how you organize and how you structure information flow for autonomy really goes back to the Burns and Row experience.

NORBERG: How do you think you came on this notion when most other people were not looking at the organization of firms in this way?

STRASSMANN: Not true, not true. There was a guy by the name of Warren Bennetts (?) at the Sloan School. And Doug McGregor, who in the big discussion about theory x and theory y, of how you organize, went back to, really, the 1950s; actually going back to work by Kurt Levin in the 1940s. So many of these ideas of autonomy and purposefulness of organizations really go back to the Sloan School.

NORBERG: Were they beginning to filter into management circles at this time?

STRASSMANN: No. People like Shepard and Bennetts, who were the great organizational design teachers in 1953 and

1954, really did not have validity in management circles. I believe that human beings build, always build on top of prior experiences. In other words, knowledge is cumulative. It's sort of webbing on top of webs. And so, almost everything I have done, ever, always connected to something else I've ever done before.

NORBERG: What was involved in setting up this new profit center approach in this company?

STRASSMANN: Very significant restructuring of the organization. The power of the chief engineers, who really had... In those days, a professional engineer had to sign drawings, so the drawings could not be signed unless the chief engineer had signature over it. So the chief engineers basically held the company as a hostage, which was okay when the old man, Ken Row's father, was the chairman. But when Ken came in with a different kind of an environment, moving out of power into defense with different contractual relationships, the thing is much more complicated. You could not really run a company with 2000 engineers on a departmental structure any more because of the big problem of communication. Also, once you deal with many small projects, which is the way defense work is done, rather than a giant power plant. You know, you build a megawatt plant. You know, the whole company works on that megawatt plant for three years. Everybody eats on that. Then you do the next plant. This is like building cathedrals. Well, when you are in defense work, you don't build cathedrals. You have this extra and this extra. You know, suddenly you have two or three thousand projects, each having a different contracting agency, and different extras. So when you change the customer relationship, you have to change structure. Structure follows strategy. When you change strategy, and you go from a small number of jobs to a large number... And of course, the relationship between the engineers and the utilities is different than the relationship between the engineers and the Defense Department. I was Ken Row's confidant in actually restructuring the management processes of the company.

NORBERG: Was he aware that such a restructuring needed to be done?

STRASSMANN: Oh yes, absolutely understood it. He was the architect of it. Well, he was sort of the guy who had the

grand vision... something to do with his personal outlook. And I was the guy who actually did the wiring, and the costing, and changed the reporting, and did project profit analysis. I mean, many of those things, which subsequently paid off to me in other areas.

NORBERG: How was this problem similar to or different from the problem on the turnpike authority?

STRASSMANN: Computationally, it was much more trivial. The problem of profit accounting on a project basis in an engineering organization is computationally trivial as compared with that. The problem is input and behavior, and design and validation, and the whole problem of extras: who is accountable and how do you tie in budget estimates with actual progress payments? And how do you tie it in with percentage completion reports. I mean, there's a whole mess in here. And suddenly, instead of having four chief engineers who are accountable, you have 50 project managers. Some of them are bad; some of them are good. They also have to be able to do some wheeling and dealing.

NORBERG: Among themselves, or with the customer?

STRASSMANN: Both. They are all competing for a pool of resources. A very, very interesting experience. I was able to get high-level management organization information design. That was the beginning. I wrote a number of papers for Ken Row on the relationship between organization and information, which are, by the way, very good papers. I looked at those papers recently.

NORBERG: And these were internal documents, for the company?

STRASSMANN: Oh yes.

NORBERG: Did you get any guidance from the nature of contracts with the defense department in terms of what sort of

reporting was necessary to the government, what sort of accounting?

STRASSMANN: Oh, yes. I spent a lot of time with the Air Force procurement agency.

NORBERG: Now, were those specifications different than the ones that would have been given by municipalities, that would have involved in building...?

STRASSMANN: Of course, these were cost-plus projects subject to audit. Then we got into atomic work. We did some of the work on shippingport. So we were subject to an audit by AEC. We started working on the Bomark missile, which was really my specialty. We got involved with the early work with Bernard Schraver out in the ballistic command out in El Segundo.

NORBERG: Wouldn't those have required a classification?

STRASSMANN: Yes, but it was so loose and so general. They really didn't have their administrative thing buttoned down. There were a bunch of free-wheeling jockeys out there. Those were wild days. I mean, this was the late 1950s.

NORBERG: When I went with Westinghouse, in the Bettis Atomic Power Laboratory in 1963, it was sort of a cursory investigation to give me a classification. But, indeed, there were questions asked and there were long forms to be filled out. And if you had been denied classification in one circumstance, how would it be granted in another? [Pause.] I was wondering if you knew anything about that.

NORBERG: All right. Now, in 1959, then, you suggested you changed...

STRASSMANN: In 1960. I stayed for a while, but ultimately, I knew that I couldn't make headway. So I stayed at

Burns and Row from 1955 to 1960; although in 1959 I had the decline of the secret -- actually it was a special kind, it was not just secret, it was secret plus something. So then I started looking for a job again. I really liked management very much. I became very active in the Institute of Management Sciences, starting in the mid-1950s. I became the program chairman for the New York chapter in 1956. And I was a founding member of the College of Planning. I was very, very active. I got to see quite a bit of the crowd, the New York crowd, particularly the people from the GE Corporation, who were doing some outstanding work in strategic planning. I was very much intrigued by that sort of thing. The executive director of the Institute of Management Sciences was Harold Covet... I worked with him. I became editor of the *Journal of the Institute of Management Science*, which was a fine journal. It still is, by the way. I wrote some very good papers, by the way. I wrote some very, very good papers on risk analysis that were published. One day Harold Covet called me and said that General Foods is looking for a controller of construction; namely, a person who would overlook the investment in plant. And of course, that was extremely well paid. Corporations in those days paid much more than engineering companies, and the benefits were important. We had a second child and the benefits were important and so forth. My wife has very good artistic taste. And she always likes art, and so forth. And so I decided money's important; family's important. Also, it was less travel. General Foods was in White Plains, we lived in Mount Vernon. So you know, it's a local commute: getting off the train rather than going on the subway to downtown New York where all the engineering organizations were. So I came in as the controller for the engineering department of General Foods in May of 1960. And my duty, basically, was to review all world wide plant construction for investment in machinery. My signature was mandated to be on the sign-off sheets. When there was a capital appropriation request of over $100,000, my signature had to appear on it.

NORBERG: Along with how many others?

STRASSMANN: Like six others. You know, there was the head of engineering and the division general manager... You know, those were the days of big corporate bureaucracy and so forth. I did this for about three months for General Foods. And one day I get this appropriation request to add 50% capacity to all the warehouses in General Foods. There

were 25 of them -- distribution warehouses. And that was like three quarters of a million dollars apiece. These were district warehouses from where you shipped Jell-O and Post Toasties and what have you.

NORBERG: It sounds like the turnpike problem again.

STRASSMANN: Oh, sure. The problem is always the same, believe me. The problem is always the same. It comes in different forms, but the problem is a certain shape. And it comes across my desk. And all the signatures were already on it, and it was just for me to sign. So I said, "Well, let me ask a few questions. Well, when were these warehouses built?" "Well, they were built last year." And I said, "Well, wait a moment. Why do you want to expand them by 50%?" There was a justification in there; we were already in outside storage. In other words, we were going to save money by bringing in things, to bring it in-house. It met the payback criteria, the R&I criteria, the whole thing -- just sign. I said, "Well, wait a moment. I want to see the original justification." So we went around and around. And again, in the sort of hard-nosed way that I had with the drillers; it either kills me or promotes me. And the nub of the story was is that, indeed, as soon as they built warehouses, in order to smooth production they were just pumping production, in order to keep their unit manufacturing costs down, was just loading the warehouses with inventory. Meanwhile, the marketing department invented the notion of deals; you know, five cents off, three cents, you know, this kind of a coupon, that kind of a coupon. So there was lots of obsolete stock out in the inventory, which was going to be junked. Of course, the distribution department was run on the basis of their yearly cost per square foot. The production department was being run on the basis of their unit manufacturing cost. The marketing department didn't give a damn. They just got their bonuses based on the kind of deals they invented. Of course, what happened was the thing that was the buffer between all of those parochial interests was inventory. You know, it just went up and up and up. So, what I did was something quite interesting. I took Forrester's Dynamo, and I did a hand calculation. And I proved in one afternoon, based on a hand calculator, that the system was oscillating. It behaved exactly the way Forrester predicted. In fact, there is a very important paper I wrote about it, called "Systems Oscillation and Organization Design." It behaved exactly according to Professor Forrester. What basically happened when you wire certain organization systems a certain way, and if the

feedback loops are delayed, and you have accumulation points, the thing will just fill up. So I take this computation and I go see Jim Stone, who was the head of Jell-O, who was the biggest culprit. I mean, they had forty years of lime Jell-O in Atlanta.

NORBERG: You're kidding!

STRASSMANN: Forty years of lime Jell-O supply. Again, because of the distortion, you know. They had an awful lot of lime jello. They had it in the wrong place, in the wrong packages; but they had enough lime jello. Management only looked at aggregates. This is like the turnpike. The turnpike is one guy at one gate at 1:00 in the morning. So this bloated inventory was a result of all kinds of local distortions. And I go to Jim Stone and I say, "Look, Jim, you know, your problem, really, here is that there are huge delays between marketing, production planning, distribution, and production. And so what happens is that everybody compensates for everybody's error. And then the feedback loop back to production planning is such that they only look at accounting data about inventory stock, because these distribution centers have tab machines. And so the tab runs don't come in. By the time they come in, they are a month old. They represent, on the average, information that is 45 days old. The production people plan four months out, because the materials have to be ordered. Your pipeline, in fact, is 47 weeks long.

NORBERG: Forty-seven weeks?

STRASSMANN: Yes.

NORBERG: A long time.

STRASSMANN: And so what happens, of course -- once you have a stick that is flexible and is 47 feet long and you try to touch a button, you can't. Well, he liked that analogy and he said, "Well, okay. Now what do I do?" Again, he was a

practical guy. I said, "What you have to do is you have to rewire the damn thing. What you have to do is you have to get instant inventory back to production planning. You have to stock up, not on finished goods, but stock up up the pipeline; namely on packaging material. If you scrap, you scrap packaging material. It's cheaper." He said, "You know, I've been thinking about it. This is exactly what I want to do. How do you do it?" To make the story short, he took me off the job, after three months, as the construction controller. I became head of a special office to redesign the inventory system. I did redesign it.

I teamed up with C-E-I-R, which was the most responsive service bureau in those days. They had a 7090 at Union Carbide at 250 Park Avenue. I got all of the inventories off the districts to go on teletype, paper torn-tape teletype. They would come every Friday night into General Foods. This is 1962 now. And I redesigned the way the production data was being done so that the computer printout was basically doing like a sidewinder. In other words, it was honing in on the right spot. In other words, the production schedule every Monday issued short term production orders and shipped orders to every plant. You know, there were three Jell-O plants, and so forth, and two Minute Tapioca plants, and so forth. And within a year, the system was called COPT. It used exponential smoothing equations. Exponential smoothing, as you know, hones in. It does smoothing ahead. And I basically computed, for every stockkeeping unit at every location, for every deal, a weekly forecast 8 weeks out, and then computed the error in the forecast when the new data came in, which means I had a weekly recomputation, both of the accumulation and the error and the rolling forecast. So it was a dynamically self-correcting system. Whatever errors there were, they were caught in the packaging material, in the raw material, which, of course, were fungible, so they could be switched. Inventory came down by an enormous amount. Within the year and a half, they had empty warehouses. Then I went to Maxwell House, and I did the Post Toasties and what have you. And within eight months, I became the head of systems for General Foods.

NORBERG: There are a variety of questions here that I feel compelled to ask. One that interests me personally more than, perhaps, would interest others interested in computing in operations research is what happens at a Jell-O factory when you decide that you don't need as much lime Jell-O this week? Can you shift to another flavor of Jell-O, or does the

factory, itself, compress, and people get laid off on a sort of weekly or monthly basis?

STRASSMANN: Well, let me just tell you what Alt and Hettle... They consolidated all the plants into one, so they could smooth production. They went to Dover, Delaware, which they wanted to do anyway. You see, they smoothed employment by piling up inventories, which was all right when you had a small number of brands, small number of flavors, small numbers of promotions; it worked. When the system went turbulent, dynamically unstable, the system just ran away. You see, systems and organizations have dynamic properties. They work on the laminar flow, and then when you go turbulent, you cavitate the whole organization into oblivion.

NORBERG: But that didn't happen to Jell-O, did it?

STRASSMANN: Well, it was going that way.

NORBERG: I see.

STRASSMANN: And the symptom, of course, was that they wanted to add all of that warehouse capacity. But it only made things worse. So the Forrester analysis in operations research, and, you know, understanding of the interlocking. In fact, the funny story I have to tell, is that when you then do what's called partial analysis of the system... You know, you have to look at the choking points. There was one guy, by the name of Rambo, who was in charge of packaging materials. Now Rambo was an old timer. All the marketing guys were new Harvard MBAs doing all of these deals. Now Rambo once got caught with scrap, because on the operating statement at the bottom was all the financials, and at the bottom was scrap. And Rambo said, "I ain't going to have any scrap." So Rambo imposed on all these MBAs who came and went, didn't know what was going on; they were totally oriented towards the ad agencies; and said, "If you guys want to have a deal, you have to order packaging material 18 weeks ahead of time." It turned out, that cost you about one third of the inventory, because he imposed on every lead time that 18 weeks. You see, one of the techniques that you do

in organizational analysis, you do work flow analysis, and then you simulate the dynamic responses of the organization. I have programs that do that. I had programs in those days. This is like servo-motor simulation. This is like flutter analysis. Forrester wrote a language called Dynamo that does that. There's another language called GPSS, which I used, by the way, to do the rigorous case. And Rambo, already in packaging material, stuck out like a sore thumb. He contributed most of the oscillation. All you had to do was retire Rambo, put an MBA who didn't know what he was doing in charge of packaging, you would already have gotten half of your savings. Well, so much for computers and operations research.

NORBERG: I'll ask you how Rambo stuck out in a moment.

STRASSMANN: When you do the dynamic analysis, you have partial...

NORBERG: I'll ask you about the dynamic analysis, but I want to ask something else first to keep the trend going. Who did you work with in C-E-I-R?

STRASSMANN: The big guy who came from IBM. What's his name? Robinson. He was a big guy. But I worked with a Hungarian woman who did my real programming. She came from aerospace.

NORBERG: What was C-E-I-R like in the office you dealt with, structurally?

STRASSMANN: Well, it was the local office. You know, Jack Moshman was really running the big shop down in Washington, right off the airport, in Crystal City, what is called today Crystal City. Jack was the real brains. Union Carbide bought a 7090 and they didn't know what to do with it. There was a guy by the name of Jim Townsend of Townsend, Lowe and Leasy, who was in charge. He conned Union Carbide. Union Carbide always bought these monuments, you know. And so C-E-I-R made a deal with Union Carbide to buy half of the capacity of that machine.

Then they got a hot-shot salesman by the name of Lee Rydell, who died of a brain tumor, to go and pedal this stuff. And here I again, with a toll collector, you know, I talked myself into a giant project that I don't understand. Well, I said, "Fine, we're going to set up a data base, and pump all of the data in, and run all of the exponential smoothing equations, and we'll just run it every Friday night. And, by the way, you had to run it by Friday night, so it would be at Grand Central in the mail pouch by 6:00 in the morning. You see, it had to go to Orange, Massachusetts. It had to go to upstate New York, and so forth.

NORBERG: By 6:00 on Monday morning, or 6:00 on Saturday?

STRASSMANN: Saturday morning, so that production people could schedule their plant, and do the scheduling of their...

TAPE 2/SIDE 2

STRASSMANN: ... fancy stuff. I mean, this is as close to real time as you got in those days. In other words, I had inventories as of Thursday night teletyped to Jell-O Foods in White Plains on a torn-tape system, which was in place. They took the torn-tapes. They made punch cards out of them. Friday morning, they ran by station wagon down to C-E-I-R Friday noon. And on Friday night, C-E-I-R ran this giant... I mean, it was a giant run. I mean, these were ? of computations. And all of the printouts were collated, put into pouches, which were pre-prepared and they went by pouches to Grand Central Station, which was just around the corner, to be mailed out. You didn't have Federal Express in those days. Okay, these were big, big runs. The runs basically told the plant what is the situation for every unit, in every warehouse. It did a planned rebalancing. In other words, from time to time, when a plant would have taken a hit, we just changed territories. This thing also reallocated territories. Now, sometimes you ship to Mississippi. Sometimes you ship this way. Of course, it didn't work, because to bring the inventory down, you have to really squeeze production.

And so that had to be done by Saturday morning. So this guy, Levi Dell said, "Well, I've got this 7090 time." Now, this was 1962; 7090 -- a big commercial application doing exponential smoothing on a production environment every bloody Friday night was quite an achievement. General Foods has had that system until about five years ago.

NORBERG: What sort of cost was involved in a contract with C-E-I-R?

STRASSMANN: That was expensive. They over-ran. But the running cost was not that much.

NORBERG: Well, I don't mean just the running cost on the machine, but the cost to do the analysis and prepare everything, and so on.

STRASSMANN: Well, it was cheap. It was cheaper than... You see, General Foods had all these tab machines. General Foods didn't have computers. You see, when I started this, I rattled all kinds of cages, because you have in the bowels... I worked for the engineering department. Now you have to understand that I worked for the engineering department. The controller has a huge tab shop in the basement in White Plains. The tab shop issues all of these inventory reports, on the average, 45 days too late. And I come in and say, "Forget about it." I take the work away from the tab shop. I go to outside processing, which is a no-no; you know, this is rape. I bypass the controller department, who of course, had the monopoly on this technology. The IBM sales people got mad at me, because, of course, they were counting on installing computers in General Foods. You know, I take the cherry away. I take the big application away. And of course, it runs like a dickens on a 7090. You know, they cannot sell too many mainframes to General Foods. Now General Foods is White Plains, which is the backyard of IBM. And the salesman who loses, you know, the next upgrade at General Foods is very visible, because all of the local guys go and check up on the local office. You have to understand the subtle dynamics of this thing. So the running costs of the 7090 is peanuts. In fact, it's a cost reduction as compared to this report that was 45 days late that came out of the basement. The big cost was the program. It was late. It over-ran twice, because we really did not know what we were doing. The equations were not that bad, but it's making sure that you have

the full set of transmissions, that they balanced out. It's the commercial part of it, the front end, which C-E-I-R didn't know how to do.

NORBERG: Could you be a bit more explicit for me? I'm not following all the details.

STRASSMANN: You get a bunch of cards. Well, those cards get out of sequence. There are warehouses that don't report. There are codes that don't get reported. There are cards that get mispunched. This is a ? five-level code, so there are errors in the transmission. If you just run through the equations, they blow up.

NORBERG: I see.

STRASSMANN: We got the OR model, which I wrote, done as a piece of cake. And then, we got slogging when we discovered all of the front end bugs, and then the back end bugs. And then management, in the middle, says, "Well yes, we bought this, but now you want us to rebalance territories. Well, that's easier said than done." In other words, if I want to move supply boundaries dynamically, unseen by human beings, there is no time between Friday afternoon and Saturday at 6:00 in the morning. You know, I spent weeks and weeks Friday nights sitting at the console when there were kickouts. You know, my wife said I had a mistress -- every Friday night in New York (laugh). This went on for months and months. I spent about $200,000 just to get the damn thing programmed, which was treble the initial estimate. I was this far from being fired, but then the thing ran. Boy, it ran!

NORBERG: When it did run, were you able to reallocate?

STRASSMANN: Oh, yes. When we were in production mode, it just ran. I didn't have to go there Friday nights. Then I started peddling it; it was installed in Canada; it was installed in England; and *Fortune* wrote about it, and so forth. By the way, when *Fortune* wrote in 1962 or 1963 about the coming impact of computers on organizations, they had only two

case studies: Westinghouse and their Telecomputer Center and my case, General Foods, Jell-O. Those were the big stories of 1962.

NORBERG: Can we go back now to the problem itself? You've identified some of the variables in the problem. You've identified where some of the problems arose in people's reporting, or lack of reporting, whatever. And you have these identifiable problems, at least, that will cause the...

[INTERRUPTION]

I started to say, you knew something about the variables in the problem and you knew something about the problems in those variables in terms of reporting, and so on. What was the approach to the programming taken by you and the people in C-E-I-R in order to solve this problem? In other words, what was available to you at the time in terms of programming skill and examples that could be used for this sort of problem?

STRASSMANN: Well, the General Foods staff had no skills whatsoever, so I had to go and really take what C-E-I-R people convinced me that they knew how to program. They were very anxious to do a commercial programming, particularly something that would run every week. So it would bring in continual revenue. I listened to them, and people like Jack Moshman convinced me that these were professionals. They had these programmers. They wanted me to write out in long hand the computations and give them a sample. They said, "We'll just give it back to you, all ready to run." So I didn't get involved in programming, but it was programmed in assembler. Part of the routines were done in FORTRAN. The thing had to be extremely efficient, because the thing had to be overlaid. I mean, programming understanding (?) was not very great, so they had to do all kinds of handstands to get this thing done. They ultimately concluded that this was a very, very complicated application. In other words, the pieces were simple. But the way I wanted it done, the crossfooting and the subtotaling so that when it hit the plant, the plant could actually see what they should do, and then go and look in the detail. I mean, it was a very fancy output.

NORBERG: Were they capable of making the judgements about how to bring it to this bottom line number or instruction for the plant, or did you have to explain the process to them?

STRASSMANN: I did all the formats and designed all the interfaces. In other words, I gave them mockups. In other words, when I do things, and I still do it, I actually say, "This is what I want to see." And I'll give them a dummy. In other words, a thing like this I would actually give. And then, of course, I negotiate, "Well, can you do it?" Then I go back and I change it. But I always give output specifications.

NORBERG: So you thought you knew the solution to the problem and you were simply giving it to them.

STRASSMANN: Oh, I knew the solution to the problem. I had done the dynamic analysis. I had know that I had to do 13 week exponential smoothing in weekly increments. I knew that I had to do an error computation. I knew that I had to show safety stock. I mean, there are lots of variables in there. In other words, the question is what is the lead time, what is the truck distance, what is the emergency shipment opening? What's the quarterly budget? What is the year-to date? So that you can self-correct; in other words, if you are way below pace, there will be a surge, which means you have to jack-up your exponential smoothing constant. There's lots of things that you do. Once you're over the budget way, then you sort of take a more conservative... All of that thing was automated by hand.

NORBERG: Do you think that this is necessary in problem solution even today?

STRASSMANN: Oh, you better believe it! Even more so, because the execution of the code is becoming more and more trivial. So the design issue, the understanding of accuracy levels, the understanding of the displays so people can use common sense, cognitive verification of output becomes more and more important. Because otherwise, the crude juggling of numbers overwhelms people. And people just take these things blindly, and then you go to a disaster.

NORBERG: Without trying to lead the witness, what would you say, then, has been the trend in software development since this period of, say, 1962 through to the introduction of micros and what we see as packaged software today?

STRASSMANN: Oh, things are just getting much easier. In other words, C-E-I-R had to a data base manager just for that application. Nobody would do that today. Nobody would do that today. They had to hand code the standard deviation computations on a period basis and they'd queue them. You see, not only do you need period standard deviation, you need cumulative standard deviation. You buy that routine today. There were some attempts at plotting, you know, XXXX. Well, today it would be a piece of cake. You would just do it. You would call a subroutine and that's it. With on-line capability, you would not have to do all of that printout. If I would do that design that took me so many Friday nights and Saturday nights in 1962, that thing could be done today at a fraction of the cost, and it would be ten times better.

NORBERG: So would you say, then, the key word in describing software today is flexibility?

STRASSMANN: Flexibility, yes. Flexibility, and it's canned. The hunks of knowledge that have been put into a can you don't have to reinvent. You can build at a high level of abstraction.

NORBERG: Would you remind me again how long this project took?

STRASSMANN: Oh, eight months.

NORBERG: So, were now, roughly, at the end of 1962?

STRASSMANN: Yes.

NORBERG: What happened then? Can we scratch that question? What was the reception within the company to the results of this project?

STRASSMANN: Euphoric.

NORBERG: On both ends? Executive management, as well as plant management?

STRASSMANN: Plant management was very happy, because for the first time, they could see downstream. When you do one of these applications, you have to give everybody added value. And so, part of the design was that on the printout that the plant got, they, in fact, got the marketing plan. You see, I had to put the marketing plan in. The quid-pro-quo in all of these kinds of situations is that everybody has to be better off, and then they are willing to swallow all kinds of other things that are imposed on them. So they got the deal schedule. They got, as of Thursday night, Monday morning inventory stages in every warehouse they served. You see, the plant used to incur all kinds of loading dock penalties, because those guys used to scream, "I need an emergency shipment!" Well, an emergency shipment comes out of the plant manager's budget, not out of the marketing budget. So you had all the way this contention. People cry wolf and so forth. And now, you know, they guys say, "Oh come on Charlie, the truck left here and you've got 50,000 units there. What do you want from me?" So the plant got empowered. The central staff got empowered. Central staff used to get it from every side. Marketing liked it because very often deals were held back, because management finally said, "Look, we have just got too much of the old stuff." Rambo got early retirement; cursed me all the way. To the very end, he was convinced that he was doing the right thing for the company, you know, (?) scrap. "I was doing my job better than anybody else in this god damn company." Well, everybody was better off, really. Then inventories came down 30 million and no warehouse expansion.

NORBERG: Thirty million dollars?

STRASSMANN: Thirty million dollars.

NORBERG: Per year?

STRASSMANN: No. Thirty million in inventory.

NORBERG: What was the inventory if it came down 30 million? Before it came down?

STRASSMANN: It was about 80.

NORBERG: Eighty. So it was almost in half.

STRASSMANN: Oh, yes. It was nice. It was very nice. Service went up. This was one of these good ones. And of course, talking about executive management, the chief financial officer of General Foods, Tom McDay, said, "Well, you know, we either kill this guy or we co-opt him." (laugh) You understand that?

NORBERG: Yes.

STRASSMANN: And so I got promoted and became director of MIS. The basement shop came under me and so forth. And that's where I made my first mistake. I thought I had it. And of course, all the divisional control heads were just waiting. Now that he's in the control shop. And then, you know, this is the great story of the Hatfields and McCoys of the '60s and the '70s; you know, the struggle between MIS trying to assert itself as part of the executive process. And MIS is a handmaiden and messenger of the finance establishment. That is a discussion of epic proportions.

NORBERG: Well now, how did that proceed within General Foods?

STRASSMANN: Well, with General Foods it was very simple. I became number one MIS guy in General Foods. I started doing some marvelous things. I built for General Foods the first media model. You know, General Foods was the second largest purchaser of advertising. I cleaned up inventory and so forth. I got into Birdseye. There were some very interesting problems.

NORBERG: You sort of skipped over the media modeling problem. What was that?

STRASSMANN: Well, one of the big questions is, how do you allocate media money? There are all kinds of programs, all kinds of exposures, all kinds of effectiveness. So we built in 1963, you know, in my shop, a huge, huge model for looking at the effectiveness of media; really a par excellence model -- also riding on the 7090, by the way.

NORBERG: Using C-E-I-R?

STRASSMANN: Oh, yes. It gave a big, big competitive edge to General Foods. And then...

NORBERG: Please don't leave that. I'm thinking about all of the recent studies that have come out about advertising and whether or not advertising is effective in the marketplace in terms of convincing new customers, especially, to buy this product.

STRASSMANN: Oh, no. I didn't do that.

NORBERG: No. I realize you're talking about the allocation of resources.

STRASSMANN: The allocation. In other words...

NORBERG: Within the company.

STRASSMANN: In other words, there's x million dollars, 180 million dollars for advertising. The question is if you have 800,000 places to put it... Again, this is like the toll collection problem over and over again. The advertising is a spot at 6:05 on WABC feed in Spokane. Are you going to buy or are you not going to buy?

NORBERG: Now, on what criteria are you going to decide to buy or not buy?

STRASSMANN: The answer is that those criteria were generally understood, but computationally were intractable.

NORBERG: I see.

STRASSMANN: This is back to the toll collection problem. Remember, it's a pattern. It's a toll booth, or racks in a warehouse, or a spot in Spokane. It's the same problem, structurally.

NORBERG: Would you make a decision on the basis of how much Jell-O was being sold in the Spokane region?

STRASSMANN: Yes, but there is a whole table of variables. Computationally, nobody could handle it. The agency couldn't handle it. And there were not many agencies, all vying for their piece. So all I did is I took all of the heuristics, plus all of the things like audience, frequency, count, cost, mashed it together, and gave the ad people a set of displays. They could cope with it. That's all.

NORBERG: Yes. Now, what would be in these displays?

STRASSMANN: A coefficient of expected effectiveness. It was at the micro level. You see, until then, everybody did everything at gross level.

NORBERG: Meaning nationally, in this case.

STRASSMANN: Nationally. Let's go with this campaign. Yes, but you know... Don't you know, this is Florida? And this is a different demographic set. And therefore, you are in Palm Beach and you don't want to show this thing, you know. You don't want to show a casserole at Palm Beach, certainly not in prime time. But they used to do that, because they had no way of... I mean, the thing is very, very complicated. They had no way of extracting it. Ultimately, you have to cut orders. We are delivering to you this tape, so you can show this thing on such and such. There is a whole industry there getting an enormous amount of money for doing all of that thing. And this computer just basically allowed the advertising department of General Foods to centralize purchasing power. Remember, there is a power element. I don't know whether you saw that in my book. I said, information is power, and the cost of information is more a reflection of the typology and the structure of how information flows than the intrinsic value of what you do.

NORBERG: In the case of the media allocation problem, was there any feedback which would allow you to judge whether or not the expected effectiveness...

STRASSMANN: That's after I left. The feedback is a much more complicated thing. Then you have to get into Nielsens. You have to get into shelving. Those kind of problems didn't get solved until you had the optical wands, so you could, in fact, do market by market sampling of what the customers were really doing. You know, that took another 50 years to solve.

NORBERG: Back to your list then, commenting on which sorts of problems you investigated after that.

STRASSMANN: I mean, lots of problems. And then I looked at the problem and, basically, my view was that computerization will not happen in General Foods unless you -- and remember, this is the '60s, early '60s -- until you bring in the technology under central aegis. In other words, the first thrust of technology should be to bring in big mainframes, and bringing enough of a critical mass so you can bring in-house the programming knowhow, and start building data bases, and go with Ramax and so forth, so that you can, in fact, start moving in that direction and, also, get off the torn-tape system, and start going into switched traffic. And that's where I made my first mistake, my first big mistake of my career. I told my boss that I would do a plan, a long range plan, because until then, there was no long range plan. In other words, information technology was funded, you know, on an annual cycle. And I did, basically, a ten year plan. I still have the plan here. And by the way, that plan is as good today. Ultimately, they ended up doing it. And I said, "Centralize and take, basically, the technology out of the hand of the divisions." And of course, that became a huge political rhubarb. Ultimately, the way this thing was resolved... The only way how the corporate guy could pull it off was to bring in all line divisional control. In other words, you have to co-opt. By the way, the controller of General Foods, Tommy Day, a very distinguished guy, was the military governor of the Philippines under MacArthur. This was a very senior guy, a very savvy guy. And he did the right thing. And he said, "Well, okay. I had my technology fling. This is a political thing." And so he brought Detweiller, the division controller who was the biggest opponent, over me, as the new vice president of information systems of General Foods.

NORBERG: Rather than promoting you?

STRASSMANN: He couldn't promote me. I was too young, too new. I was not part of the establishment. To centralize, you had to co-opt these controllers. I thought I could do the job. Detweiller was a jerk. He really was. They fired him, by the way, a year later. He made a total ass out of himself. But meanwhile, of course, you know, I blew all of my good will. This was part of the wars of the '60s. Of course, many other companies did that in the '70s.

NORBERG: Why do you say it was a mistake?

STRASSMANN: I was right, but I was pushing too hard too fast. In other words, I had a sense of urgency; the organization did not. The organization has alliances, connections, which built over many, many years. You cannot just come in, and because you are right, sort of rip them out. Of course, my sense was that if I don't rip it out, the technology will start coming in and imbed itself in the wrong place at the wrong economic level. I thought I will stay with General Foods forever and take ten years to rip it out. And by the way, it had already started, because Detweiller ordered an RCA 305, and the new plant in Dover, Delaware, got themselves a Honeywell 400. You know, we saw it coming. In other works, divisions were going for dissimilar manufacturers as a way of sandbagging the corporate IBM shop.

NORBERG: Were they doing this with design? Sandbagging?

STRASSMANN: Come on!

NORBERG: I want to get you to say it. I don't want to be guessing at this.

STRASSMANN: Arthur, those are the realities.

NORBERG: I'll grant that, but do you know indeed that they were sandbagging?

STRASSMANN: Oh absolutely. Well, sandbagging, you must understand, is done much more subtly. RCA was very much anxious to collect the account. So RCA basically gave the machine, which was a bum machine, which didn't have a COBOL converter. But they were going to bail out Detweiller in Battle Creek, Michigan, by giving them just bodies. So Detweiller had no cost on conversion from tab equipment. In those days, what's called the seven dwarfs, had all kinds of crazy ways of buying into big corporations. So Detweiller, this so-called sandbagging, implies that it was irrational. It wasn't irrational. You could get deals out of RCA that you couldn't get from IBM, so Detweiller said, "Look, this is what

I'm going to do." When you finally looked at it from a risk analysis standpoint, it actually cost more. The machine subsequently had to be ripped out anyway. I mean, the RCA never stayed there.

NORBERG: Was this the same problem with the Honeywell 400?

STRASSMANN: And, of course, then I got General Foods to take over responsibility, and the crazy Brits went with ICL equipment of 1301. And I said, "You know, this is never going to work." I saw all of this stuff coming in. IBM was selling Ramac to the distribution warehouses, 305s, and 1401s to corporate, because IBM has always practiced that kind of split and provide (?)... That gets you lots of hardware into the place, but it all gets sandwiched in. By that time, I knew that, ultimately, you would have to go to data control. You see, I achieved data control through that ? application by getting just raw teletype and then going through lots of formatting. So I oriented inventory, supplied a main data base. Now I wanted to move it in. And I said, "If I don't do it in the next two years, I won't get it done." But the company did not appreciate the thing. And so I worked for Detweiller, like, three or four months. And then Arthur Anderson came and said, "Oh, well, we hear you're in trouble, but have we got a good deal for you!" In 1964, experienced MIS guys were very hard to find. "There's this big company, which is bigger than General Foods, and would really like you. They will just go with standard architecture. Would you come and work for them?" It was called National Dairy Products Corporation, really, Kraft. National Dairy was a holding company of Kraft, Sealtest, Breakstone, and so forth; bigger than General Foods, a different kind of a company. So I came in as the head of MIS in June of 1964.

TAPE 3/SIDE 1

STRASSMANN: I think you are getting the flavor of the wars and the history and the atmosphere of this thing.

NORBERG: Yes.

STRASSMANN: National Dairy really wanted a global system. They had to, of course. They had perishable goods, and they shipped an enormous amount of pick lists; in other words, you have trucks and remember, when you deliver cheese, you have to take the cheese that is overaged, you have to take it back. So you really are vertically down to the store. You have to account for what's net shipment. So the data processing problem of National Dairy, and Kraft, and Sealtest is vastly greater, because you have all of these trucks and you have route salesmen doing the delivery, doing on the spot decisions. It's a very complicated data processing problem. So, although on the New Jersey Turnpike I had 18 interchanges with an average of 6 gates each, the world was really a 6 by 18 world. The General Foods world was 25 by 500; 25 locations, 500 SKU. When you finally graduate to the Kraft world, you're talking about 4000 by 8000. The thing gets bigger. Ultimately, you're delivering chocolate swirl ice cream to a cooler in a local luncheonette and putting it in. You don't have time. So this becomes a mammoth management problem, how you do it. And the cost becomes significant. I did lots of work for them to sort of set the stage for the architecture and so forth; brought in some very good people from the outside. Of course, at Jell-O Foods, I brought in lots of new blood. And then I brought in lots of new blood, also, to National Dairy. Lots of people from General Foods followed me.

NORBERG: That's what I was just going to ask you.

STRASSMANN: Yes. I had one guy who followed me from General Foods to National Dairy to Xerox. Also developed new things like the relationship with audit; really thinking through what is the function of MIS. You know, one of the big problem is how much of a monopoly it is. The question of audit: who is the policeman and who is the good guy. Lots of issues got sorted out, at least in my mind, in National Dairy days. Those were more leisurely... This was a much higher level job, dealing with the whole question of charge-outs, you know, cost accounting. Suddenly, you start doing work on a multi-divisional basis. Many of the principles, which go back to Burns and Row, namely that every project is a profit center, the notion of a data center is a profit center, many of those ideas start maturing, and then you

find ways of implementing that. It was a good couple of years. It was 5 years there, global, going to Europe and to Latin America and to Japan, getting into the international issue, the data interchangeable issues. Many of those issues about trans-border data flows. There are all starting to be interested in those days. I don't know what else to say, except to tell you a funny story.

NORBERG: Tell me the funny story. Then I have a few questions to ask about it.

STRASSMANN: Well, go ahead with your question.

NORBERG: Well, I was going to ask you what the professional field was like at the time. MIS must have been developing as a professional field. Was it emerging out of the management schools? Was it emerging out of application? Was it emerging out of OR?

STRASSMANN: The management schools had nothing to contribute in the 1960s and 1970s. I mean, there was an intellectual vacuum there. And, by the way, I maintained my professional credentials. I published articles. I did an important article in the *Harvard Business Review*. I was a frequent speaker before Diebold, and so forth. And so, I was one of the guys that was visible. But the university, really, had nothing to tell me. Nothing. There was no research out there. There was some esoteric things, bordering on astrology coming out of Harvard; sort of drawing squares, and you're at this station in this square. And if you are in this square, you have this square; sort of drawing things on unlabeled axes without scale.

NORBERG: The O'Brien scheme for development of information system technology inside corporations.

STRASSMANN: You don't mean O'Brien, you mean Nolan.

NORBERG: Yes. That's right.

STRASSMANN: Well, that's astrology; very popular in those days. Those were the intellectual achievements. But there were no intellectual constructs coming out of the field anywhere, dealing with the fundamental issues of cost justification, funding. Let me just talk about budgets. My budget at National Dairy was 18 million dollars. That was a huge pile of money in those days for computing.

NORBERG: Based on what overall budget of National Dairy?

STRASSMANN: Oh, it was a three billion dollar company. In those days, everybody was looking at revenue-to-expense ratios, so it was still three-tenths of a percent. But I saw it going to 1% and 2%. Meanwhile, of course, in the '60s and the '70s, you started building huge professional staffs: programmers, systems analysts, auditors, lawyers, coordinators, market research people. This is the period when America built overhead, big skyscrapers and so forth. My feeling was, particularly once I started having to go and explain my budget... As you know, I'm sort of very analytical -- prove it to me -- I didn't have any numbers. So in National Dairy, I started building cost structures. As a matter of fact, my seminal articles, my seminal article in the *Harvard Business Review* issue of 1979 is managing the cost of information, which some people consider a big milestone. I basically said, in 1979, you have to be right. You have to be rational, because you're going to run into all of these irrational [reasons]... you know, technology is good for you, and those kinds of things. That's what the professionals like. During the 1960s, you wiped out all the tab managers. In other words, all the guys who came with you from the 1940s, and the 1950s, and right through the 1960s. The tab managers generally didn't make it into a 1401. They tried. And then you had...

NORBERG: So what happened to these people? Did they leave the company? Did they get reassigned? Did they retire?

STRASSMANN: They retired, you know, became coordinators, became input coordinators, became user representatives. There was lots of room out there, because the bureaucracy was just getting bigger and bigger. And computers, of course, demanded user coordinators, user representatives, input editors, output reviewers, document reporters. A whole list of new categories got bred. I mean, I created jobs. I mean, the moment I created this cop (?) system for General Foods, or this media system, immediately it created lots of jobs just to analyze the stuff that was coming out.

NORBERG: So here's an impact that is sort of buried in the labor statistics.

STRASSMANN: And, of course, it's deeply buried. Numbers indicate that for every dollar that you spend on information technology, you create seven dollars on the outside, from the narrow definition of IT. You saw in my book, for instance, I point out that a $2000 micro costs you really $18,000...

NORBERG: Yes.

STRASSMANN: ... and stuff like that.

NORBERG: I brought that to the attention of my staff.

STRASSMANN: I'm being charitable. So, you see, there is great probing. It's IBM's heyday, and they are pumping the iron. Big Blue really intellectually dominates in the 1960s and the 1970s, basically by hitching their wagon to the finance executive, who sees the computer as really the capstone of the financial executive's desire to captured totalitarian control over the organization without increasing its budget. That's the '60s and the '70s, in spades. The issue is control. Therefore, the shops migrate under the financial executive, who has a great emotional stake in the MIS establishment. The people who come in and get the key MIS job are basically the creatures of the accounting establishment. When you

look at the budget allocation, you see that 75 to 80% of the computing dollars from a functional basis is going to control, in one disguise or another. Marketing gets some. Production gets hardly any. And things like field service and so forth get zip. For instance, I started looking at functional distributions of budgets. Personnel is nowhere even on the map. You never hear of those guys. They like their secret little folders, you know (laugh). So that's the intellectual environment. It's totally dominated, and IBM is doing extremely well, because IBM is totally attuned to the mentality, the form. They wine and dine the financial executive. They establish a whole infrastructure for dealing with the financial executive. The financial executive is conned every time he goes with high-tech guys. He always bombs out, because the high-tech guys don't deliver; not because the problem is technology, but the problem is all the other things around the technology. So the financial executives sort of trust IBM, and IBM is really helping the financial executive, really helping.

NORBERG: Now, does any of this show up in the MIS literature of the time?

STRASSMANN: None.

NORBERG: That is, this association of in between...

STRASSMANN: None of this shows up.

NORBERG: Are there any later retrospective looks at that problem that you know of?

STRASSMANN: Yes, there are, by Dickson, from the University of Minnesota; Charlie Kriebel from Carnegie writes about it, but in a very oblique way. IBM comes with a BSB technique, which is their methodology, which then gets adopted by Arthur Anderson. So IBM populates the environment with an infrastructure in intellectual contents of how you actually do systems. You see, even I'm in there, but I'm working for the chief financial executive. And I'm too much

enmeshed in this thing to really deal with this thing.

NORBERG: That's what I was trying to probe for.

STRASSMANN: Yes. You're too close to it. And in fact, when you say, well, who else can I report to. This is in the late 1960s, 1970s, people started to say, "Well, you should really work for the president." Well, you know, it doesn't work. You know, some people try. Jim Rudy [?] , at Pillsbury, works for Terry Held [?], for awhile, which is a very interesting case study. The problem, of course, with Jim is he gets too much on the speaking circuit. And so, you get alienated from your organization. Those are extreme cases which all get truncated and decapitated. I think Jim Rudy talked about it quite a... He, perhaps, may have been the most articulate guy. He founded an organization called SMIS, but the thing isn't strong enough, yet, to really articulate an identity. You suddenly started the rudiments of the MIS people really looking for power, and since they can't have power in their own right, they never could, they never will, getting reflected power as the satellite of the controller is the safest solution, considering the alternatives.

NORBERG: Yes. To round out the discussion, to make it similar to the earlier statements that you made, were you as active in professional organizations in this period as you had been in the late 1950s when you were editor of the ISI publications, and so on? What sort of things did you belong to in this period?

STRASSMANN: Oh, you know, ACM. I'm chairman of the finance committee of ACM. I became, for instance, one of the members of the certification board of DPMA. I wrote the code of ethics for holders of CDP. And so, you know, I'm continually active. I'm doing my thing for the profession. I teach, lecture, and so forth.

NORBERG: How did the opportunity at Xerox come up? And with that, we'll bring this to a close. We'll talk about Xerox next time.

STRASSMANN: I think it's a funny story. It's a capstone, because it's rooted in this behavioral thing. Here I am with National Dairy, pumping out 450,000 invoices a week, pieces of paper. And I upgrade from 1401s to 1460s. And, of course, the 1460s aren't much of anything. I was steamed. So I look around and I say, "Gee whiz. Let's just order 360s," because I really need a machine so I can migrate, write my code once forever, get out of Autocoder, go into COBOL, all of that good stuff. And of course, IBM promises this to me. So I place one of the biggest orders there is for 360s. I order something like 25 machines or something like that. Well, I'm a big boy on the block. And I say, "When can I test? When can I test? Oh, you know, it's great!" Alpha test results are fantastic. "Let me in on alpha." "Well, you have to wait for beta." The beta never comes. And, of course, I'm running out of capacity. You know, IBM comes back and says, "Well, why don't you get yourself a 7010? We'll help you with the conversion?" I said, "I don't want a 7010. I'm going to go to a 360 to take a tab emulation which has been spiked to fit a 1401, sort of [?] into 1460? Now you want me to go with a 7010. You guys are crazy. I haven't got the time." And they continued to give me this expensive iron. So one day, I go back to my friends at Honeywell. I said, "You guys have got this Liberator thing. How about a little Liberator?" I had some good friends who had been wining me and dining me for a long time. And they said, "Well, you know what deal we're going to get you in a Honeywell Liberator configuration. And we are going to do the conversion. You don't have to pay us anything until the thing runs." Well, of course, I know, if Strassmann buys a Liberator in National Dairy, with over twenty 360s on order, I mean, that's news. I mean, they are not exactly dummies. They are not giving me anything for free. I am nervous. I have a data center manager in Philadelphia, who is ready to try anything. He's sort of a wild duck, and I say, "How about a little Liberator?" Oh, great, it can run your COBOL. He's a COBOL freak. He can't run COBOL on the 1460 to be worth a damn. So we get the Liberator installed. It goes in like a greased bullet. It just goes in, and runs. It just runs, and runs beautifully, double the throughput, the tapes are beautiful. Everything is perfect. So, you know, I have the Liberator in in a month. I threw out the 1460. And that's when hell breaks loose. You know, I get these calls. I don't have to tell you, you know, people... You first get called by the district manager for lunch. Then you get called for lunch with the regional manager. Then somebody flies in from Harrison. And it's always, like, stress. "Are you SURE you really know what you're doing?" You get this sort of arm twisting. Of course, they cannot unhook, because, you know, this is the United States. Well, I have a guy in England, in Birmingham,

by the name of Alex Moon, who is a wild guy.

NORBERG: Alex what?

STRASSMANN: Alex Moon.

NORBERG: Moon?

STRASSMANN: And Alex Moon said, "Geez, this thing..." He cries and sees the Liberator in Philadelphia, is sick and tired of ICL. We have forced down his throat a 1460, which he hates, because he doesn't get along with the Brits. So he says, "Give me one of those machines. I'm going to install it right away," which he does. Now you are in a world trade. Now you are open season in the world trade, because you can get unhooked. You can get unhooked in the world trade. You cannot get unhooked in the United States.

NORBERG: What do you mean by unhooked?

STRASSMANN: Come on! You know what unhooked is.

NORBERG: No. The machine doesn't. What is unhooked?

STRASSMANN: Under the consent degree, IBM cannot come in those days, if you place an order with a competitor, to unhook the order, you cannot use countervailing pressure. The trade term -- I'm surprised you didn't hear the term -- in the antitrust trial, the unhooking thing became a very big issue. In fact, Norris won SBS in that settlement because he was able to prove an unhooking in one case, and he had them over the barrel with Justice. But in world trade, you are open season, because, you know, it doesn't apply. So suddenly I started getting phone calls from World Trade. And of course,

they assign "hit men", you know. And the guy who is assigned to me as a hit man is a guy by the name of Joseph B. Flavin, who is the chief financial officer of World Trade. They are very good in choosing the right size of the gun for the right target. And Joseph Flavin gets on the phone. You know, he's at United Nations at the World Trade, and I'm right across the street, 39th Street and Madison. We have this long conversation. And of course, Joe Flavin is a much more direct guy. And we have this funny conversation. He said, "You know, I'm going to golf this weekend with Edwards, who is the chairman of National Dairy, and I just wanted to sort of understand the facts and all of that." So I said, "Look, Joe," -- by that time we are very friendly, Joe and Paul, you know -- "I placed an order for your machines. All you have to do is ship me that order at the price, at the performance, and I have no reason to install the Liberators, because, you know, I'm an old IBM man. I've been working with IBM since 1955. I wrote my master's thesis on IBM equipment. I've been born and bred in Endicott, and all of that. You know, I owe my whole career to IBM. Why should I go away? You guys are fantastic and I like this 360 equipment, because I want to be able to grow [?] this thing. Just ship me the machine." I said, "Ship me a beta test machine." Well, you know, they had a priority list and there was a list and so forth. They'll ship me a 7010 and charge it from me at 360 prices. And here we go again. I said, "Look, I just have to get invoices out. That's what I get paid for." So this meeting takes place over my head; this is two layers over my head. My management says, "Well, Strassmann is getting invoices out. So Strassmann wants to get invoices out and he has IBM equipment on order, and you guys haven't shipped. What do you want?"

NORBERG: That's a good backup.

STRASSMANN: Of course, these are milk guys. These are nice people, but plain kind of people. This is not fancy kind of stuff. They said, "The guy's doing his job, placed an order with you. What do you want?" So I started installing these Honeywell machines, and of course, there were problems with Honeywell, and of course, ultimately, IBM delivers and so forth. Now it's 1969. In April of 1969, I get this phone call from one of the really, really top class headhunters. He said, "Paul, would you have lunch with me at the Union League Club?" When George Beck calls you and wants to have lunch with you -- the League Club serves a very good salmon mousse -- you go for lunch. And so we go and talk about various

things. "You know, I have a client. This client wants to get rid of all its IBM equipment." I said, "This must be a sort of a crazy client you got, George." He said, "Nope. They want to. They did a survey, and they discovered you are the guy who really knows how to sink IBM equipment and get rid of IBM equipment. And they want you." And I said, "Now, wait a moment. I mean, fine, but I'm very happy with National Dairy and everything is fine. I like the people. They back me up." He said, "Well, how much money do you make?" I told him. [Telephone interruption.] I hope this doesn't sound too ? ...

NORBERG: No.

STRASSMANN: So the guy doubles my salary. And I said, "Okay, but where is the location?" "Rochester, NY." I have never moved in my life. Remember, I've never moved. I've always lived within eight miles of my mother-in-law. This is my second house. And I said, "I'm not moving to Rochester." "Well, go for an interview, anyway." So I conveniently arrange... I'm on my way to headquarters, Kraft Division headquarters in Chicago. I drop off at Rochester. They have a big, fancy limousine at the airport waiting. They whisk me into Xerox tower, up to the 29th floor. And they say, "Mr. Flavin would like to talk to you."

NORBERG: Mr. Flavin?

STRASSMANN: Mr. Flavin now is the executive vice president of Xerox. "Oh, I'm so glad to see you. I have something very confidential to tell you. We are going into the computer business, the commercial business. The first thing I have to do... [telephone interruption]... I'm very sorry. He tells me that the deal is on with SDS. And they have a checklist of all the things they have to do. The first thing they have to do, of course, is get rid of all IBM equipment, and install SCS equipment inside Xerox worldwide. And he doesn't know of a more capable hard-nosed S.O.B. than me to do it. He knows by now how dogged I am and he would just like to offer me the job as the chief computer executive of Xerox. It was really a big salary boost and a large amount of stock options and what have you, which of course, built all

of this thing [his house]. I cannot say no. If there is anything I need, everything is negotiable. I said, "I'm not moving to Rochester." So he takes this long look at me and says, "You are a tough man, but let me tell you something that nobody knows, other than Peter McCollough. We are moving to Stanford." So when Flavin makes the announcement, because he is sort of chief of staff, that Xerox is moving corporate headquarters from Rochester, which was very traumatic, in order to be a global company. And he said, "The second reason we are moving to Stanford is we wanted to hire Strassmann (laugh) and he wouldn't come to Rochester." And this has dogged me. I've been with Xerox for 17 years, and people still remember that. So that's how I got to Xerox. And I got in with the express understanding that my performance, my bonus, and my subsequent stock options were based on my ability to get rid of IBM equipment and make SDS equipment work in a commercial environment.

NORBERG: All right, but I don't see the perception of these people about your being hard-nosed with IBM and getting rid of IBM equipment at National Dairy as being the same sort of thing as you described to me. In every case saying, "Look, I've made the order. Just send me the equipment. I'm not trying to leave IBM."

STRASSMANN: You must understand that when you are an IBM customer, you don't even consider an alternative. I mean, the mental set is that if you are true-blue, you would never consider even defecting, regardless of whether you placed an order or not. I'm conveying to you the mental set. I was hard-nosed, suspect, and a defector.

NORBERG: This sounds like a good stopping point to me. We'll pick up with Xerox on the next visit.

END OF INTERVIEW