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Donald P. Gaver (interview)

Naval Postgraduate School; Gaver, Donald P.

PATRICIA JACOBS: I am Patricia Jacobs. I am a Distinguished Professor of Operations Research at the Naval Postgraduate School. And I am here to interview my colleague, Donald P Gaver, Jr, who is a Distinguished Professor Emeritus of Operations Research at the Naval Postgraduate School. I've been working with Don for over 30 years.

He is a very distinguished person. He's won many awards over the course of his career. He's been named fellow of many societies. And in 2009 he was elected to the National Academy of Engineering for contributions to reliability, maintainability, and queuing concepts, with applications to telecommunications and military systems.

So Don, I'd like to start from the very beginning. Where were you born? And who are your parents?

DONALD P. GAVER: Well I was born in Saint Paul, Minnesota on February 16th, 1926. And my parents were Dorothea Haman Gaver, and Donald Gaver Sr. And I was brought up in Saint Paul, and want to the Saint Paul Academy for most of my pre-college training.

PATRICIA JACOBS: What occupation did your father have?

DONALD P. GAVER: My father was a small businessman who ran a shoe findings company in Minneapolis, with his brother Carl.

PATRICIA JACOBS: Were there influential people when you went to the Saint Paul Academy?

DONALD P. GAVER: Well I can remember several. One was my chemistry and physics teacher, Russ Varney, V-A-R-N-E-Y, who was a very fine and stimulating kind of a guy. As well as my mathematics teacher, Ameluxen I've forgotten his first name at the moment. But he was-- Fred I think it was-- he was a very nice and distinguished guy too. But he was rather apt to get angry at students if you didn't do the right thing. So I tried to do the right thing.

PATRICIA JACOBS: That's good.

DONALD P. And I won a cup when I graduated from mathematics. It was called the Sprague cup. And it's

GAVER: not clear to me exactly what it rewarded, but I was very much interested in mathematics, particularly since we went into the period of algebra. Algebra really attracted me. And I taught myself the rudiments of calculus also. So that was-- I was ahead of the game at that point.

PATRICIA JACOBS: That's good. And then how did you decide to apply to go to MIT?

DONALD P. GAVER: Well frankly everybody told me I should go there. And I suppose that was just advice of some kind. But it was a good idea.

And I kept up doing it. And I was admitted without taking any exams when I graduated. But at that point was about to be, or had been, drafted into the Navy. So I went in the Navy for two years.

I was put into a training program called Radio Technician. Later it was called Electronic Technicians Mate. And we learned how to maintain radars and radios and all like of things like that, even some sonar.

PATRICIA JACOBS: Where did you do some of your training?

DONALD P. GAVER: Well I started out going to the Great Lakes Naval Training station for what's called boot camp. And then I went to actually right here in-- at the Del Monte hotel, where I was housed in a room with three or four other people. And took classes in more advanced Electronic Technicians Mate material. And I did pretty well.

After that I was sent to Navy Pier in Chicago. And worked there for almost a year. I got sick at some point and I stayed there for about a year, and then was sent to the island of Guam. I graduated with a second class seaman rating, which was considered to be quite an in of those times, in those situations. But then I was sent on a-- I was put on a PC boat that was stationed in Guam.

PATRICIA JACOBS: And the Del Monte Hotel is currently the site of the Naval Postgraduate School.

DONALD P. GAVER: Well it's one of the sites.

PATRICIA JACOBS: One of the sites.

DONALD P. GAVER: It's the main building, the main building. So it was like, kind of amusing to come back here after some time later.

PATRICIA JACOBS: So when you left the Navy, you then were admitted to MIT?

DONALD P. GAVER: I went back, I went to MIT. It took me-- it took them about three or four months to let me come there, because there was a huge horde of people after World War II. But I entered the Navy-- no, I entered MIT in about January. I think that was 1946.

PATRICIA JACOBS: And you were originally going to go into engineering and science?

DONALD P. GAVER: I had elected to do electrical engineering early on. But after I'd been there for awhile the head of the math department said, why don't you think about majoring in mathematics? And I had formed a relationship with one of the professors in the math department, named George Proctor Wadsworth. And he induced me to come into the mathematics, and also study the rudiments of operations research, which had been formed at the time of World War II.

PATRICIA JACOBS: And what piqued your interest in probability and statistics?

DONALD P. GAVER: Well I thought that it was a very interesting and useful and universal type discipline. And so I followed with-- I learned as much as I could about it at that time. And I continued thereafter.

PATRICIA JACOBS: Well even probability and statistics are relatively new areas to be taught in universities at that time. Who were the faculty that were giving courses in that?

DONALD P. GAVER: Well this man Dr. Wadsworth was one, Professor Wadsworth. Another was Dirk Struik, who was a professor that also taught me analytical geometry. But he taught a course in probability. But I found some of those teachings to be a little dry, so I was happiest when I was able to get jobs offline helping use my knowledge and learning capabilities to study meteorology and oceanography a small amount.

PATRICIA And then you received your bachelor's degree at MIT. And then you stayed on for a master's

JACOBS: degree?

DONALD P. GAVER: That's correct. I did my master's program under Dr. Robert Solow, who is a very talented and excellent teacher and person, who later won a Nobel Prize in Economics. So I did a thesis under him.

PATRICIA JACOBS: He must've been a young man at the time.

DONALD P. GAVER: Who?

PATRICIA JACOBS: Robert Solow must have been a young man at the time.

DONALD P. GAVER: Oh, he's only a couple years older than I am.

PATRICIA JACOBS: And how did you happen to choose him as an adviser?

DONALD P. GAVER: Well I want to talk to Paul Samuelson, and Samuelson said well why don't you go with this guy? So I did. And I never regret it. I took courses from Paul Samuelson, who is a well known economist. But I took other courses with Robert Solow, and really thought that was very entertaining and educational.

PATRICIA JACOBS: And what was the topic of your master's thesis?

DONALD P. GAVER: It had to do with the decision making under uncertainty. So it was sort of the beginning of the period of decision analysis using probability and statistics. That's not the whole title, but I can't recall the whole thing.

PATRICIA JACOBS: So after you earned your master's degree at MIT, you left and you went to work for-- who did you work for after leaving MIT?

DONALD P. GAVER: I went to work for an outfit called The Operations Evaluation Group, which was in part of the Pentagon in Washington.

PATRICIA JACOBS: And its initials are what? OEG?

DONALD P. GAVER: OEG, exactly.

PATRICIA JACOBS: And what did the group do?

DONALD P. GAVER: Well the group was the supposed to analyze data and the taking and acquisition of relevant data to improve the operations of the fleet. And so I did various things like this, I arranged some data analysis type activity, which was something a little bit new to me. But it worked out pretty well.

And I stayed there for awhile, and I made the acquaintance of Robert Hooke, who was a faculty member. Oh not a faculty member, but he was a full member of that group. And he advised me after a couple of years to go to try to acquire a PhD. And he recommended me to John Tukey.

John Tukey being a leading figure in statistics at Princeton University. So I went to work under John Tukey, and I was there for about three years. And after awhile Tukey introduced me to Willie Feller, William Feller, under whom I did my PhD thesis. And that had to do with solving queuing problems of various kinds. And it was rather on the side of what's called now applied probability, which is a field that I really like very much and endorse, and hope to continue in for some time.

PATRICIA JACOBS: And how did the topic of queuing come up, as far as your thesis was concerned?

DONALD P. GAVER: Well it came up through an example shown to me by one of my faculty members, on of my advisers at OEG. And I got to liking this area. And at that time I also was sort of mentored by Bernard Koopman. And Bernie Koopman was really excellent at this kind of thing. And we just sort of worked together and I could have gone-- he was recruiting me to go to Columbia for a PhD in applied math and probability, when I kind of was determined to go to Princeton.

And it was set up. And I went there with working with Tukey. Not so much with Tukey, but mentored by him. And then I was introduced to William Feller, who was my PhD thesis adviser, who is a very amusing and talented guy.

PATRICIA JACOBS: Well he wrote a two volume book on probability models, which has been very influential--

DONALD P. GAVER: On theoretical and applied probability--

PATRICIA JACOBS: --in its applications.

DONALD P. GAVER: --I think it was called. And they are excellent books. The first one came out about that time. And when I was at summer school at MIT, I took a first course in that kind of probability with a man named Marc Kac, who was a professor at I think NYU, or I've forgot where, actually. But he was-- even though he had an accent and had trouble dealing with the summer heat, he was really an inspiring guy. I still have the notes that I took from that class, and he was a great man.

PATRICIA JACOBS: Well he was a very eminent probabilist.

DONALD P. GAVER: A what?

PATRICIA JACOBS: He's a very eminent probabilist.

DONALD P. GAVER: Oh yes, yes he was, indeed. And I valued that greatly.

PATRICIA JACOBS: Bernard Koopman wrote a very influential book on search theory.

DONALD P. GAVER: That's right. Well it's not really a book. It's more of a report. He did that under the auspices of OEG. But he was a very talented man. He had a background both in physics and mathematics. So he was really very good treating problems as they arise. I learned a lot about problem formulation from both him, Koopman, Bob Hooke, and somewhat from Willie Feller.

But Bob Hooke was sort of assigned to mentor me, because he'd been a college teacher. And he was very good. And excellent at formulating problems. I think one of the biggest issues in

applied probability, or applied mathematics, is that recognizing a problem's essence, and trying to turn that essence into a mathematical formulation. And that I think was very well taught there. I really benefited from that.

PATRICIA JACOBS: This is at OEG?

DONALD P. GAVER: At OEG, yes.

PATRICIA JACOBS: And Bob Hooke was particularly good at it?

DONALD P. GAVER: Well he was good at this. And there were others also who were quite good at it. I can't name their names at this moment.

PATRICIA JACOBS: Well Koopman probably.

DONALD P. GAVER: Well Koopman was very good too. And he mentored me in these things. So I have no regrets about being there at all. I think it's a superior thing to do, but prior to going-- working on a formal PhD.

But anyway at one point I left and went to Princeton to do that. I worked for a year in an outfit that John Tukey had formerly called a-- oh I've forgotten it. It was sort of an advisory group to people. It was rather like OEG in fact. And then I--

PATRICIA JACOBS: And did you work on military problems, or something else?

DONALD P. GAVER: Yes. Yes, we worked on military problems. And Navy problems, or whatever. So anyway then I went to graduate school. And again, I spent most of my time working on queuing problems.

PATRICIA JACOBS: Well queuing I think was a relatively new field at that point.

DONALD P. GAVER: It was, yes. David Kendall had formed-- was really one of the first people to discuss these kinds of problems. But there were some Russians also. I trailed along. I solved a problem that

had to do with delays. And at least in a later paper I wrote something-- the first paper that really came out of my thesis. It was my thesis redone, and it was published in the Annals of Mathematical Statistics.

And although I value doing things of that kind, and publishing in that kind of journal, it's hard to get that kind of thing before the eyes of a real decision maker. I think it's important that we-- in this field-- be sure that we can get these things, these ideas and methods, into the eyes of real decision makers. So we continue to do that, even here. You and I do that.

Let's see now. One of the things that I did that I got interested in was the field reliability, maintainability, and all that sort of thing. And I found sponsors for that in various branches of the service, Navy. That everybody has the problem of trying to maintain in good order complex equipment that is used in warfare these days, and also in other places. And so I tackled that.

A lot of the work that was done in that time was, in my opinion, somewhat naive. The assumption was that antiquated items like vacuum tubes would fail at the end of an independently distributed, exponential lifetime. And so things of that kind were notable in the field.

Well what I did that I think changed some of that, was to treat situations in which items failed because of external shocks, things of that kind. And if that happened, then maybe several would fail simultaneously. And much of the theory had to be revised to deal with that. And I had some of the earlier papers on how to handle such common cause failures.

PATRICIA JACOBS: Once you graduated from Princeton you then went to Westinghouse Electronics--

DONALD P. GAVER: I went to Westinghouse for about four or five years. I've forgotten how long.

PATRICIA JACOBS: And what kinds of problems did you work at Westinghouse?

DONALD P. GAVER: Well there I was a pioneer in helping them understand how electric power networks should be maintained and thought of. There again we have issues of failure. And I created a large scale simulation procedure that they used for studying power outages and how to guard against them.

And we invented a-- I, together with another engineer from East Pittsburgh, Westinghouse-- invented a method called *Power* Casting in those days. And that had to do with forecasting how much new equipment and connections one needed to maintain reliable electric power to consumers. So that was my principal thing at Westinghouse.

PATRICIA JACOBS: Well and that's a problem that continues today.

DONALD P. GAVER: It does continue, and has to be continually updated. And I'm not sure if they're doing all they could, but I think they're doing great things. And I think they're somewhat inspired by what we-- I and Clarence Baldwin, my coworker-- invented and publicized. There we really went out and talked to power companies and representatives thereof, and made our points in person. Which I think is a very valuable thing to do.

PATRICIA JACOBS: Did you-- well let's see. I noticed that you took a sabbatical from Westinghouse, was that--

DONALD P. GAVER: I was given a sabbatical, and I went to Stanford, to the statistics department there. And while I was there I taught courses and I met notables like Sam Karlin and Kai Lai Chung and others. And I took classes from both of them. And I just generally valued that experience. I learned more about statistics and probability, and it was a pleasant interlude.

PATRICIA JACOBS: Who were your classmates at Princeton?

DONALD P. GAVER: Princeton. Well Henry McKean was there about the same time. He's a well known theoretical probabilist. He's written some books on integral-- stochastic integral equations, things of that kind. He was a very talented guy. He had some personal problems, but that was one of them. I've forgotten who-- I'm trying to come up with some other names, but that was the one who was the most prominent.

PATRICIA JACOBS: So when you came back from sabbatical at Westinghouse, you were back at Westinghouse. Why did you decide to take a faculty position at Carnegie Mellon?

DONALD P. GAVER: Dr. Richard Duffin was a mathematician at Carnegie Mellon, who I got to know and like. And he suggested I apply to Carnegie Mellon. And I did.

And I began to work there. And when I went there, I began-- I went there sort of on leave. But

then I left. At that time I was a member of a group that was managed by Robert Hooke--

PATRICIA JACOBS: At Westinghouse?

DONALD P. GAVER: At Westinghouse, yes. So then I transitioned to Carnegie Mellon. And there I got friendly with people like M.M. Rao, and Morris DeGroot. And Morrie DeGroot was a great guy. But he was a little-- I thought he was a little too entranced with Bayesian methods, but--

PATRICIA JACOBS: So he was primarily a statistician?

DONALD P. GAVER: He was a statistician, not so much a probability modeller. But very capable. And very well understood.

PATRICIA JACOBS: And what department were you in when you first got there?

DONALD P. GAVER: I was first in Mathematics. And then Morrie DeGroot and I started the statistics department there. We were the first people in, and we sponsored faculty.

PATRICIA JACOBS: Were you working in statistics at that time, or you were working in applied probability?

DONALD P. GAVER: Well I did some things on statistics. I got kind of interested in things like jackknifing and bootstrapping and all that.

PATRICIA JACOBS: Did you keep contact with John Tukey?

DONALD P. GAVER: Yes I was sort of friendly with him. And also Willie Feller. But Feller and Tukey had a sort of friendly rivalry.

So once when I went back to Princeton for a reunion or something, I ran into Feller. And he asked me if I'd like to have dinner, and I said I would like to, but I'm here because I want to go to a seminar that John Tukey's running. And he said, "why would you want to do So anyway, back to Carnegie Mellon. It was a good experience by and large.

PATRICIA Do you remember what problems you were working on when you were at Carnegie Mellon?

JACOBS:

DONALD P. GAVER: I'm having trouble. I think again I worked on some problems that had to do with maintainability and things of that kind. I'm probably forgetting something.

PATRICIA JACOBS: That's fine. And then, well let's see. When you were at Carnegie Mellon, did you take another sabbatical?

DONALD P. GAVER: Yes I took another. Well it was a leave. I want to UC Berkeley for a year, and kind of enjoyed that. And I was at that point involved in solving problems having to do with road traffic.

So I spent a lot of time in the Traffic Institute at Berkeley. And I met a man named-- well I went there under the auspices of Dr. Gordon Newell, who was my good friend.

PATRICIA JACOBS: Once again a very eminent-- I guess he was trained as a physicist?

DONALD P. GAVER: Yes, he was. And he was a very able guy. He could formulate problems quite well. And he was-- he'd written a little book about queuing theory.

And he was quite good. As well as a good friend of mine. We used to see him a lot socially. Also I met Adolf May, Dolf May, who was in the traffic department really at Berkeley. And I worked with him over on the Berkeley operation.

PATRICIA JACOBS: So then you returned to Carnegie Mellon from Berkeley--

DONALD P. GAVER: Yes.

PATRICIA JACOBS: --and then somehow you made your way out to the Naval Postgraduate School. How did that happen?

DONALD P. GAVER: Well Jack Borsting--

PATRICIA JACOBS: Who is that? He was Head of the Department then?

DONALD P. Head of the OR Department here and NPS. And he came to see me. And after some--

GAVER:

PATRICIA JACOBS: In Pittsburgh?

DONALD P. GAVER: That's right. And he invited me to come out here again, back to the NPS. And at that point the OR department was fairly meager in staff. So I did come, and I enjoyed it reasonably well.

I had a few differences with some of the members of the Department of that point. But I did enjoy it. And so when the chance came, I just decided to move here from Carnegie Mellon. It seemed like the thing to do at that time of life, and my wife has always enjoyed smaller communities, than even Pittsburgh. So Fran and I, and our children, came out here and stayed.

PATRICIA JACOBS: Can you tell us about colleagues that you had here?

DONALD P. GAVER: Colleagues that I had here.

PATRICIA JACOBS: Like Hamming was here.

DONALD P. GAVER: Oh yes. Richard Hamming, who I had met before while giving a talk about reliability at some meeting, Richard Hamming was a distinguished guy, and a very pleasant and nice guy. Though a little acerbic. But anyway, very enjoyable and pleasant company. His only fault was they didn't drink any wine or anything like alcohol.

PATRICIA JACOBS: He was a very eminent computer scientist.

DONALD P. GAVER: He was, he was. And he was a good thinker in everything he took on. So I enjoyed his company for several years. And then somehow he became ill and died, which was a terrible blow to me. But he was a very good colleague here.

He came out here from Bell Labs. And I had met him at Bell Labs when I was either at Princeton or Westinghouse or somewhere doing some operations research type work there. So he was good.

PATRICIA JACOBS: There was what, John Wozencraft?

DONALD P. GAVER: Oh Jack Wozencraft was another person who was here, who had been a professor at MIT. I hadn't known him when I was there. But he was a very distinguished and great guy too. I really enjoyed working with him.

PATRICIA JACOBS: You worked on what, the Command Control and Communications Group?

DONALD P. GAVER: Yes he ran a group called Command Control and Communications. And it was pretty vibrant. And I was fortunate enough to be one of the staff of that group. So we got together and talked probably once a week. And he actually lived in my neighborhood, so we saw him and his wife, also Fran, fairly frequently. I'm trying to come up with other names.

PATRICIA JACOBS: Well that particular group is an example of how the Naval Postgraduate School encourages interdisciplinary activities.

DONALD P. GAVER: Indeed.

PATRICIA JACOBS: These curricular groups are comprised of faculty from different departments.

DONALD P. GAVER: That's right.

PATRICIA JACOBS: They bring their different expertise to problems. In this case of C-queued problems, Command Control and Communication.

DONALD P. GAVER: Yes. That is, and remains, was, and remains, a very salient topic for the military.

PATRICIA JACOBS: And then when did you meet Peter Lewis?

DONALD P. GAVER: Oh I'd met him years before, when he was at-- I think when he was at IBM. I actually knew him when he had a sabbatical type trip to England. He was at the-- he worked with David Cox, I believe. He was at Imperial College. I believe that was where he went.

So he was a good friend of mine. I had known him before I ever came out here. And when I first told him I was going to come out here, he was a little bit not quite so sure that was a great--

PATRICIA JACOBS: Well he was working at IBM then, wasn't he?

DONALD P. GAVER: Yes he was. And I had been consulting up there for--

PATRICIA JACOBS: At IBM?

DONALD P. GAVER: Yes. And written some papers with him. And he was quite an ingenious type guy, and had a crazy sense of humor. And I enjoyed him quite a bit. But then I came out here, and before I knew it he was telling me that why wouldn't I get him a job out here?

And so I worked hard on Jack Borsting and we made him an offer, and he came out here. And he came with his wife Lydia, and a couple of children. And that was pleasant. We worked together for a while. And at that point he brought you here, I think.

PATRICIA JACOBS: Yes he did.

DONALD P. GAVER: He was a--

PATRICIA JACOBS: He had a sabbatical at Stanford, where I was at the time.

DONALD P. GAVER: I see. He was a good friend of mine. I liked him a lot. He was kind of erratic at times. So anyway--

PATRICIA JACOBS: That's the end, then? Then you also-- he interacted with the people I guess at IBM San Jose, too--

DONALD P. GAVER: That's right. I was a consultant for awhile at IBM San Jose. And I've forgotten the names of the people up there that I worked with.

PATRICIA JACOBS: Well you worked with a person called Jerry Shedler for awhile.

DONALD P. GAVER: Yes I did. That's good of you to remember. He was a pretty good guy.

PATRICIA JACOBS: Let's see. Who else have you consulted for? You consulted for Westinghouse for awhile, with Bob Hooke and Mazumdar.

DONALD P. GAVER: Mazumdar, Ashati-- not Ashati, but Mainak Mazumdar was a good friend of mine at Westinghouse. And he left Westinghouse and went to the University of Pittsburgh. He's now retired. I haven't heard from him for quite awhile.

PATRICIA JACOBS: And you consulted for the Rand Corporation.

DONALD P. GAVER: I did. I worked with a man named Jack Abel down there, on logistics problems for the military. And that was a good situation. I enjoyed that quite a bit. Let's see, who else--

PATRICIA JACOBS: Have you worked for AT&T, Bell?

DONALD P. GAVER: I worked for AT&T for a time.

PATRICIA JACOBS: You consulted?

DONALD P. GAVER: Consulting. And there I met people like Debasis Mitra and some other people who were all very high class people. So I have nothing but gratitude for having done that.

PATRICIA JACOBS: And you consulted for awhile at the Electric Power Research Institute?

DONALD P. GAVER: Yes. There I knew a guy named David Worledge, who had a PhD in some form of engineering. And he and I worked on these electric power grid problems, and reliability thereof. Who else did I consult with? I should remember, but I don't.

PATRICIA Well then there was certainly IBM.

JACOBS:

DONALD P. GAVER: Yes.

PATRICIA JACOBS: And then while you were at the Naval Postgraduate School you visited the University of Dortmund?

DONALD P. GAVER: Yes I had a good friend who actually was my Naval Research Council fellow, named Siegfried Schach. And he and I became friendly. He came here for awhile, we worked on some papers together, I think in the area of meteorology and wind speed indicators and things like that.

PATRICIA JACOBS: I think that was Iggy O'Muircheartaigh.

DONALD P. GAVER: Oh that was Iggy, yes. Sorry.

PATRICIA JACOBS: So let's talk about the National Research Council Fellow program.

DONALD P. GAVER: Well that was a very generous and good program, in which certain of us were allowed to nominate and possibly recruit people who were in various branches of operations research in foreign countries. They were mostly in foreign countries. So I think I remember most strongly Dr. Iggy O'Muircheartaigh--

PATRICIA JACOBS: And he's a statistician?

DONALD P. GAVER: Yes. This is an Irish guy who turned out to be President of the University of Galway. And he and I worked on papers having to do with wind speed and wave height. Wave height and wind speed. So we have two papers about that someplace. In some meteorological journal.

PATRICIA JACOBS: And you also did something on empirical Bayes with him, too, I think

DONALD P. GAVER: Yes, OK. We may have done that. And anyway I also worked with Kevin Glazebrook, who still remains a visitor here. O'Muircheartaigh comes here every now and then too, and I've talked to them recently. And both he and Kevin Glazebrook-- Kevin Glazebrook is from England, from

Lancaster.

PATRICIA JACOBS: He's from Lancaster.

DONALD P. GAVER: And he's a very adept person in the area of sequential decision making. He's extremely bright, and very valued. And a very pleasant personality. So I visited him in Lancaster, and also had him here. He's just been here recently for a month or so. And then there's O'Muircheartaigh.

PATRICIA JACOBS: There's Lyn Thomas.

DONALD P. GAVER: Dr. Lynn Thomas is also a highly valued friend, who was an NRC Fellow. And he came and we worked on certain problems.

PATRICIA JACOBS: You worked on reliability problems, no?

DONALD P. GAVER: We worked on reliability problems. I'm trying to come up with some others.

PATRICIA JACOBS: You had Samorodnitsky from Cornell.

DONALD P. GAVER: Samorodnitsky I remember he was a--

PATRICIA JACOBS: We worked on, I think it was task allocation problems in queuing,

DONALD P. GAVER: He was a-- is a capable man. I was at one point courted pretty vigorously by the Cornell OR department. But finally I decided that the wintry weather would not suite me at this point. So I didn't go there.

PATRICIA JACOBS: Do you remember any of the students that you had in particular? You have had many thesis students.

DONALD P. GAVER: Oh gosh, I really--

PATRICIA JACOBS: Well you had our current President, Admiral Route as a thesis student.

DONALD P. GAVER: Oh yes, Admiral Route was my master's thesis student, and was quite adept. And another one was Kevin Peppe, who's a masters student also, who is now very high up in, I think it's Grumman. I'm not sure. I don't want to say, because I'm not sure. But Kevin Peppy was an excellent student, as was Admiral Route.

PATRICIA JACOBS: Can you recall any memorable research sponsors that you had while you were here? Certainly Ernest Seglie.

DONALD P. GAVER: Well yes, Dr. Ernest Seglie was probablyy my most valuable and pleasant and likable and friendly thesis research sponsor. He was a Science Adviser in the Office of Tests and Evaluation. That's a DoD office. And he was very good-

PATRICIA JACOBS: Maybe can you go into what the Director of Operational Test and Evaluation does?

DONALD P. GAVER: Yes. He takes equipments that have been acquired by the services at some point, and after they've been engineered and prototypes are built, and they've gone through developmental testing to see if there are any obvious technical faults in the system, he-- this Director -- puts them through operational testing. Where they're actually integrated into the fleet, and tried to-- allowed to show what they can do, compared to maybe old systems in military operations. One of these is to detect and to acquire targets that are inimical, and to turn down false targets are not really of concern.

So it's a very serious and important area. And Seglie was marvelous at it. There were others, but I remember him most directly.

PATRICIA JACOBS: So you've also served on some National Research Council panels. You served on one about electromagnetic pulse vulnerability.

DONALD P. GAVER: Yes, I was chairman of that, I think. That had to do with-- I'm trying to recollect what the real focus of that one was. It was to try to think of ways to determine whether electromagnetic pulses were a threat or not. And that's about as far as I can go at this point.

PATRICIA JACOBS: And then you were on one about issues of combining information.

DONALD P. GAVER: Yes, that was a more statistical one. And that's quite interesting too, because any information gathered by the military, and by T and E-- Test and Evaluation or others-- comes at quite a price. So it's very difficult to ever get what you think is an adequate sample of things.

But if you can think of ways to combine information from a particular device with information from other similar devices, or under similar circumstances, it's a ticklish but difficult and important area, if carried out correctly. But you have to combine this information in a very judicious way, or it's likely to lead to bad conclusions. So I worked on that for quite awhile.

PATRICIA JACOBS: And then you were on a modeling and simulation panel of the Naval Studies Board on Technology for Future Naval Forces.

DONALD P. GAVER: Oh my. Yes, I guess I was.

PATRICIA JACOBS: Yes you were. And then you were also on a joint American Statistical Association and Nuclear Regulatory Commission committee, on statistics and nuclear regulatory research.

DONALD P. GAVER: Wow. Yes, I remember doing this, but I'm coming up hard on details. I think it was a very big responsibility to try to do this for both the statistics society and also for operations research.

PATRICIA JACOBS: So in the computer software package MATLAB, there's an algorithm called the Gaver-Stehfest algorithm for inverting Laplace transforms. So that was actually the result of a paper you wrote quite early, and can you remember what problem you were working on at that time?

DONALD P. GAVER: Well Laplace transforms are a traditional tool for solving-- an effective tool for solving certain kinds of linear differential equations. And so I-- when you get these Laplace transforms, then you can get some information from them. But then frequently you have to ask yourself, what's the inverse of this inverse?

The inverse being, in real space-time, rather than transformed space time, you can see what's happening. And so I thought of this transform idea, which is actually rather simplistic, when I was teaching numerical analysis at one point. And it has to do with taking a Laplace transform, which is a function of a variable called s in my language, and turn it into an inverse, which is a variable of time t.

And one way to do this is to sort of make the transform-- in transform space focusing down on

a very narrow time delay, one step at a time. And this was done using not differentials, or differential calculus, but differences. And then shrinking the differences space down small, at each individual point. And that was done using this Stehfest algorithm. And it's hard to describe it in layman's terms, but it was a way of taking the transform and focusing it down on a very narrow time t, one step at a time.

So you get reasonably good results from this. However after this had been done and published and used by me, if not others, it was picked up by Ward Whitt, then at Bell Labs-- I forgot to mention him. He was an able and useful guy. And he did something else with it that used the same general sort of idea, but it was, I think, a little bit more sharply focused. And that whole issue of sort of not quite current, or it's a little bit antiquated at this point. But it was sort of useful at the time.

PATRICIA JACOBS: How did you decide what problems to work on?

DONALD P. GAVER: People would bring them to me. Or I would think of the issues. I mean people would often bring me some kind of a problem like how to-- like problems I've worked on recently have to do with a combination of logistics and combat modelling. And obviously supplies play a role in how effective you are at doing combat. And I have done this with forces on both sides, so-called Blue and Red, that combat each other, and try to do so in a realistic and serious way.

So that's the kind of problem I've been working on recently. In the past I've worked on various kinds of reliability, maintainability, or other combat problems, or search problems. Many, many things that just come to happen, and are always current. Does that help?

PATRICIA JACOBS: Yes. So the problems come from our-- we do have military, we have faculty who are military officers who are assigned here at the Naval Postgraduate School for three years roughly. And so they bring problems to you.

DONALD P. GAVER: Yes, indeed.

PATRICIA JACOBS: They always go around and asking, what are you working on? So that to have them talk to you about the problems that are of interest to them. You also get problems from your research sponsors?

DONALD P. Yes.

GAVER:

PATRICIA JACOBS: I mean Seglie always would sort of try to formulate problems for you to work on.

DONALD P. GAVER: Well he'd suggest problems.

PATRICIA JACOBS: Suggest problems.

DONALD P. GAVER: We'd formulate them together. Well that's true. Now currently I'm working on two problems with two different junior military faculty, Connor McLemore, Lieutenant Commander in the Navy - a very good guy. And Chad Seagren, a Major and maybe a Lieutenant or a Colonel, I'm not sure, in the Marines.

Both of them have brought me these combat logistics type problems of different stripes. And so I've done what I can to be as representative as possible about the treatment of these things. And be honest about what the restrictions are, and that sort of thing. So it's been-- it's always of interest to get these. Now I'm hoping to get something out of the blades move issue, that has to do again with logistics, in this case marine aircraft.

So I'm always on the lookout for those kinds of problem. For any kind of problems at all that I think maybe I can handle. If I can't handle them I try to tell them early.

PATRICIA JACOBS: I remember, this was years ago, we had a thesis from oceanography who was, this was years ago, who they were interested in different kinds of paint on board ship.

DONALD P. GAVER: Yes, this was a long time ago.

PATRICIA JACOBS: Yes. For restricting the growth of organisms on ship panels. And so he had experimental data on the growth of organisms on panels that were painted with different kinds of paint.

DONALD P. GAVER: I remember something about that. That was quite awhile ago, and I've forgotten what we came up with on that.

PATRICIA Well it was a long time ago, and it was one of our first applications of using a Poisson

JACOBS: regression model. The number of organisms were Poisson distributed, and the explanatory variable was the kind of paint.

DONALD P. GAVER: That was the--

PATRICIA JACOBS: He was Professor Headerle's student.

DONALD P. GAVER: --that was the treatment.

PATRICIA JACOBS: That was the treatment.

DONALD P. GAVER: Well yes, things like that are quite interesting. I've often used some form of a Poisson or infinitely divisible process to describe an effect, an account, if you will. And this Poisson regression is universally useful.

PATRICIA JACOBS: So you've worked on problems in areas that are attributed to traditionally separate fields of Operations Research and Statistics.

DONALD P. GAVER: Yes.

PATRICIA JACOBS: Would you comment on how you see the two fields, and their overlap and their differences?

DONALD P. GAVER: Well I think there's a good deal of overlap. In fact I think-- and I think very often people in Operations Research are maybe found in Statistics departments. But it's interesting that the Statistics department of Stanford have separated off an OR group at Stanford, in which there's some very quality people. Like-- unlike I'm blanking. But there's some high quality people in this group. And Don Iglehart for one--

PATRICIA JACOBS: And Jerry Lieberman was in that group.

DONALD P. GAVER: Jerry Lieberman started this group. And he was quite a talented young--

PATRICIA JACOBS: He was also sort of a statistician. He worked in reliability I think.

DONALD P. GAVER: Well he was more of a statistician than he was an OR person. But I think he was very good at any of this kind of thing. No matter what the names are, I think the--

PATRICIA JACOBS: Well their famous person was George Dantzig.

DONALD P. GAVER: Well that's right. He was the inventor of linear programming and all that. He was quite a high quality guy. Very high quality guy.

PATRICIA JACOBS: Where do you see the fields of Operations Eesearch and Statistics going?

DONALD P. GAVER: I think there will be more blending. I think, for one thing, we're currently in a wave of more applied interests in the field of statistics, led at one point by John Tukey's insistence of the value of Exploratory Data Analysis. And so I think one of the issues should be not only how to analyze existing data, but how to acquire new and meaningful data about a problem.

And that's right in the hands of-- that's like Operations Research. Because it has to do with obtaining data, for example, in Tests and Evaluation, about some new assets in the field. And then exploring this for its usefulness in combat. So the two I think are drawing together slightly. The statistics-- statistics is having a gigantic annual meeting this next month I guess. And some operations researchers go there, but not all of course.

But OR is having other meetings, has an annual meeting too. And so they're becoming a little more contiguous. And I think maybe that's all good, beneficial.

PATRICIA JACOBS: While you were at the Naval Postgraduate School you spent some time at the University Dortmund visiting Siegfried Schach.

DONALD P. GAVER: Yes. And I am drawing a blank on what I did there.

PATRICIA JACOBS: Well he-- well we still refer to his paper with Don McNeil on differential-- stochastic differential equation modeling of populations.

DONALD P. GAVER: No that was showing that certain ways of normalizing certain kinds of equations would lead to diffusion approximations. And that was maybe I'd done something with that while I was over there. That has been very useful. I've found that to be a very excellent way to deal with many kinds of problems. And I also dealt with that, along with Dr. John Lehocczky my valued Carnegie Mellon colleague.

PATRICIA JACOBS: Well you I guess-- well I heard that John Lehoczky interviewed during your last year there. And he was looking forward to working with you, and you immediately left Carnegie Mellon to go to California.

DONALD P. GAVER: That was not kind of me. I regret that. We had him out here. I hope to get him out here again this year.

PATRICIA JACOBS: Yes. But you worked with him on sort of voiceover data problems.

DONALD P. GAVER: More on probability modelling. We did various things, and have had various kinds of models that are pretty complicated, having to do with communications systems. But that was also about the time I was going to Bell Labs. So we had many things that we did, and I value his contributions, and his wisdom in helping me do things.

PATRICIA JACOBS: And then you visited the Free University of Belgium, and worked with Guy Latouche--

DONALD P. GAVER: Yes.

PATRICIA JACOBS: --for awhile. And you wrote a large book chapter, one of which topics was an idea called random hazards.

DONALD P. GAVER: Well that idea has been around for awhile. And I think I coined the name. It has to do with the fact that individual systems do not fail necessarily because of failure of innermost components, like the burnout of a light bulb or something of the kind, or a vacuum tube. They fail because of some kind of external jolt, a random hazard that occurs more or less in an unpredictable way.

And this has to be taken into account in any study of the maintainability and reliability of a system. They have to be hardened from the start. And then re-hardened if things turn up that

are unexpected. So that's random hazard.

PATRICIA JACOBS: Anything else you'd like to say? Any other colleague that we need to talk about?

DONALD P. GAVER: Probably forgetting somebody important. I'm not forgetting you. You're an excellent colleague, who we work on things together from time to time. And we've done a lot of work, like-- it's been you, you Pat Jacobs are a great asset, a great friend.

PATRICIA JACOBS: Thank you. So one of your research sponsors was Doctor Robert Carpenter, who was with the Navy Toxicology Division.

DONALD P. GAVER: That's right. He was quite a good sponsor, and I did some toxicology work with him. The one thing that I recall is that involved something called *compartment models,* which put diseases into various stages or compartments. And I remember working on these problems with John Lehoczky, my friend from Carnegie Mellon, and writing papers about this phenomenology, which we did by using diffusion approximations to Markov processes.

So it turned out to be fairly successful from that point of view. And also I think we saved the Navy some money as far as tests. You're saying fish.

PATRICIA JACOBS: Not Carpenter.

DONALD P. GAVER: Not Carpenter, he was--

PATRICIA JACOBS: I don't know what experimentation you did--

DONALD P. GAVER: It was humans, actually.

PATRICIA JACOBS: --was it humans?

DONALD P. GAVER: Well they were concerned about humans being infected by these toxins. So we did what we could to try and understand how various toxins would behave. And that's the end of it, as far as I'm concerned. I really can't bring up any more details at the moment. Maybe I could if I

thought about it for awhile.

PATRICIA JACOBS: So could you comment on what you think the essence of operations research is?

DONALD P. GAVER: Well as I've said before, it has to do with looking at the problems that occur in an operational or use environment for techniques, or even equipment, understanding how well these things will work to alleviate certain problems that have been turned up. Or lacks of capability that have concerned, are concerned, because of inadequate assets and use thereof. So that's a sort of roundabout way of saying that it's an applied science that has to do with finding how best to do applications of systems.

PATRICIA JACOBS: And it-- as you've been talking about your career, there's this essence of talking to people outside your area, talking about the problems that they have.

DONALD P. GAVER: Well my area is primarily that of capability is foremost of trying to make mathematical models. And so you have to talk to people outside your area to find the scenario, or setting, in which you would like to apply these techniques. And so the whole idea is to fashion techniques to suit solving solution methods to solve problems that occur in the real world, in an applied area like reliability of equipment, or--

PATRICIA JACOBS: Communications systems.

DONALD P. GAVER: --communications system delays and failures. So it takes this-- operations research is the combined effect of using these tools in those areas. It's not just doing mathematics, and it's not just studying the phenomenon in question. The attempt is made to translate necessary questions, desirable questions, into enough concreteness to allow the use of mathematics to suggest practical solutions. That the whole thing.

PATRICIA JACOBS: Well and for you and during your career it's also quite social. That you go and you talk to people and you become friends with them.

DONALD P. GAVER: That always helps. I don't think you can do these things without interacting with people, and doing so on a trusting and friendly way. It's very hard to do this as if you're a would-be critic or whatever.

PATRICIA So you talk to people to gain an understanding of the situation that they want to improve?

JACOBS:

DONALD P. GAVER: Yes.

PATRICIA JACOBS: And then you formulate a model?

DONALD P. GAVER: Yes. Then you let the model lead you to useful practical ideas. It tells you that-- that's a two way street, involving much interaction with the owner of the problem.

PATRICIA JACOBS: And then when you have a solution to the model that you have created, then you need to present the results in a way that the person with the problem--

DONALD P. GAVER: Oh exactly. You have to re-translate from any abstruse mathematics you've used into sort of practical words or graphs and things of that kind. So it has to be-- you have to complete the loop, so to speak.

PATRICIA JACOBS: So there are lots of loops. There is the first loop of what's the problem, and what's the formulation of the mathematical model. And that goes back and forth.

DONALD P. GAVER: Yes that's exactly right.

PATRICIA JACOBS: And then once that has been set, then you can use the mathematical model to obtain ways to improve whatever the situation was. And then you need to translate those back into language that the owner of the problem can understand and implement.

DONALD P. GAVER: Yes, exactly. And it's not just one such loop, there may be several. When you give the client the first interpretation and analysis of what you've seen, they may suggest other questions. So it's a lot of fun in some ways, because it is a fluid type loop. It's stimulating.

PATRICIA JACOBS: And you've been very good at it.

DONALD P. GAVER: Well thank you for saying so and that. All right. Thank you.

PATRICIA So you mentioned earlier that it was very important to be able to formulate problems for a

JACOBS: decision maker.

DONALD P. GAVER: It is. And I think that's the essence of operations research. And you formulate the problems out of situations described by the decision maker. And then you treat those in some useful way. Now I prefer to use explicit mathematics and probability theory and so on. But ordinary differential equations, stochastic differential equations, things of that kind--

PATRICIA JACOBS: You'll even use statistics occasionally.

DONALD P. GAVER: You need statistics to analyze data and compare it to the model outcomes. But having done all this, then you have to do what John says, which is to couch the results in terms that can be comprehended and valued and useful to a decision maker. That's the end payoff. And I learned this from Tukey, Tukey was excellent at seeing the essence of problems.

Also Koopman was very good. And Gordon Newell was very good. And actually Dolf May was very good, too. So I just feel very fortunate in having availed myself of all these wonderful mentoring and thinking.