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Alan R. Washburn Interview (MORS)

Washburn, Alan R.

Military Operations Research Society (MORS) Oral History Project Interview of Dr. Alan R. Washburn

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MILITARY OPS RESEARCH HERITAGE ARTICLE

INTRODUCTION

Oral Histories represent the recollections and opinions of the person interviewed, and not the official position of MORS. Omissions and errors in fact are corrected when possible, but every effort is made to present the interviewee's own words.

Dr. Alan R. Washburn won the INFORMS Military Applications Society's Koopman Prize in 2000, the *MOR* Journal Award in 2001 and in 2002, the MORS Jack Walker Award in 2002, and the MORS Clayton Thomas Award in 2005. He is currently a Professor of Operations Research at the Naval Postgraduate School (NPS), Monterey, California. This interview was conducted at West Point, New York, on 22 June 2005.

MORS ORAL HISTORY

BOB SHELDON: Let me start by asking where you were born and raised.

AL WASHBURN: I was born and raised in Pittsburgh, Pennsylvania. My parents, Lois Fellows Washburn and Stephen Merle Washburn, were first generation off the farm. They grew up around Erie, Pennsylvania, moved down to Pittsburgh, and had a family. They were part of that great movement from farm to city. And they were both teachers. I was the third and last child.

BOB SHELDON: What did they teach?

AL WASHBURN: My mother taught various elementary things, including kindergarten. One of my supreme embarrassments as a child was when I was actually in her class at Concord School. She was substituting at the time. My father didn't spend too much time teaching before he became a principal. He was a principal at Thaddeus Stephens School most of the time when I was growing up.

BOB SHELDON: And you never got in trouble and sent to the principal's office?

AL WASHBURN: Oh never. Never. Various other kinds of trouble but not that one. I was born the same year my parents built a house in Carrick in the south side of Pittsburgh. I lived in that house until I was 20. My second year in college, I finally moved out.

BOB SHELDON: What was the name of your high school?

AL WASHBURN: It was Carrick High School. The Carrick High School Raiders. It was a very small high school at the time. It's subsequently grown and become rather huge. They closed some other high schools in the area and enlarged Carrick.

BOB SHELDON: When did you start to take an interest in math and the sciences?

AL WASHBURN: I can hardly remember anything before high school. I don't know why, but my mother has pointed out I didn't get very good grades before high school. But it's sort of a blank. I had some good teachers and some bad teachers in high school. The bad ones let me know what a good one was like, so I appreciated good ones the more. One of them was Melvin Vesley. He got me interested in the Math Club.

BOB SHELDON: What activities did you do in the Math Club?

AL WASHBURN: It was sort of social math. I think we proved theorems and things like that. My father was interested in math, too. He taught me geometry during the year I was out of school due to having a detached retina. I was playing football and I think I detached it by blocking a punt with my head.

BOB SHELDON: What year was that?

AL WASHBURN: I think I was 16. Sophomore, junior, one or the other.

BOB SHELDON: Where did you go to college?

AL WASHBURN: I went to Carnegie Tech. I applied to several schools, but managed to get a Westinghouse scholarship at Carnegie Tech and didn't debate much longer after that happened. I just went there. My older brother John had gone to the same school to study industrial engineering.

BOB SHELDON: How did you win that scholarship?

AL WASHBURN: Based on academic competition. They give you an exam, and just rank the exams and if you do well at math or whatever Westinghouse Corporation wants, you get a scholarship. So that was very handy.

BOB SHELDON: What was your major in college?

AL WASHBURN: All my degrees are in electrical engineering.

BOB SHELDON: So you went continuously there for your master's and Ph.D.?

AL WASHBURN: Right.

BOB SHELDON: Which professors do you remember?

AL WASHBURN: Certainly my advisor, Richard Duffin, stands out. He was in the math department. Carnegie Tech at the time had a Systems and Communication Sciences

Program that I ended up in. My problem was always that I liked math but I couldn't actually believe you could make your living doing it. So I was trying to find some other thing that relied upon math but was actually practical. Carnegie Tech's electrical engineering turned out to be a little hardware-ish for me—I got 60 cycle hum on all my experiments. So I jumped at the chance to be in the Systems and Communications Sciences program. Anyhow I made friends with Professor Duffin and ended up doing my dissertation with him. Duffin also had some influence on John Nash, he of the *Beautiful Mind*, although I didn't know it at the time.

BOB SHELDON: What was your dissertation on?

AL WASHBURN: It was a mathematical topic called the D Transform in Discrete Analytical Function Theory. Sort of a discrete analog of complex function theory. Duffin had worked on it at some length. I remember one of the questions I had to deal with was how do you extrapolate the square root to the complex plane if you have discrete analytic functions.

BOB SHELDON: When did you first start taking operations research courses?

AL WASHBURN: Never. Operations research wasn't a discipline at Carnegie Tech at the time, as far as I know. I had heard about it and I liked the idea of applying science to operations. My feeling about electrical engineering, or engineering in general, is that, granted it's important to develop new equipment all the time, but I am just more interested in using the things we have better, instead of inventing new ones. This is a recurring theme with me. My wife worries about me ending up as a dumpster diver.

I don't recall taking a course in it but somehow I did discover two-person zero-sum games at Carnegie Tech, which was a new topic to me at the time. Optimal but random behavior has a dissonance that I find appealing. We had a student publication there called *The Carnegie Technical* in which I published an article on the subject, a popularization. I have retained my interest.

LEE DICK: Followed up with many more since then.

AL WASHBURN: Yes. That's the first thing I did that smacked of OR very much.

BOB SHELDON: When did you finish your bachelor's degree?

AL WASHBURN: In 1962. It went 1962, bachelors; 1963, masters; and 1965, Ph.D.

BOB SHELDON: Was it exceptional to finish a Ph.D. in just three years past your bachelors?

AL WASHBURN: I think so, but I'm not sure. It helps to stay at the same school and not move on. I was interested in getting out of there and seeing the world, so haste was nice.

BOB SHELDON: Did your dissertation help you get a job?

AL WASHBURN: After I graduated they had the usual recruiting fair. I had several offers, one of which was from the Boeing Company. I ended up taking that job against the advice of my advisor, who didn't like the idea of me working for an aircraft company. My parents weren't enthused about me being on the West Coast either, but I got out there and I saw the salmon rolling around in the Duwamish River and I just couldn't stand it. I had to see the West Coast. Boeing turned out to be a nice place to work.

LEE DICK: That was in Seattle?

AL WASHBURN: Yes.

BOB SHELDON: What were you doing initially for Boeing?

AL WASHBURN: I was working in an operations research group supporting the missile and information systems division. So I was working on problems involving the Minuteman ICBM, many of them associated with command and control. Boeing at one time was interested in submarines, believe it or not. A strategic weapon system called the ULM submarine.

BOB SHELDON: Is that where you first became interested in search theory?

AL WASHBURN: To some extent, yes. I think that was mainly at NPS, though.

BOB SHELDON: At Boeing, you were working in a group that was called OR?

AL WASHBURN: Bob White and Jay Miller were the people that ran it. And whatever they called it, we were certainly doing OR. But I just sort of gradually discovered OR. It took me awhile to discover that there was an OR journal, for example, and start reading.

BOB SHELDON: How large a team were you working on at Boeing?

AL WASHBURN: Twenty, some number like that.

BOB SHELDON: How long did you work for Boeing?

AL WASHBURN: I had two jobs at Boeing. I worked in the missile and information systems division doing military OR for three years. And then I went over to the commercial airplane division, working in Renton instead of Kent, and did commercial things for a couple of years. Renton is where they used to make 727s.

BOB SHELDON: What were your significant accomplishments those first three years on the military side?

AL WASHBURN: They were all associated with probability. I don't know how I got so interested in probability. I didn't think that much of the subject in college. But when I first got to Boeing, I remember there was a Monte Carlo simulation that they were doing. And one of the first things I did was to discover you didn't need to simulate, that the whole thing could be calculated fairly easily. So I was delighted with myself for doing that and then got involved in other probabilistic things. The first paper I ever wrote was motivated by that ULM, that big submarine that Boeing was interested in. And there were other mobile deployment schemes, too, because at the time, the Soviet Union was going to shoot all their ICBMs at us and destroy our retaliatory capability. One of the things we could do about that was to keep our own capability mobile.

Of course, you could put it in a submarine, which has turned out the practical thing to do. But at times people have considered having them roving around down in the southwest somewhere out in the desert or on rail lines and that sort of thing. In all those schemes there's an issue of how to move. Imagine that the Soviet Union can see and track the mobile vehicles. They'll eventually shoot at them, and kill them all, except for the fact that it takes their missiles half an hour to arrive, and they don't know what you will do during that half hour. So the question is, how should you move around in circumstances like that? "How should you move around?" was the source of the first paper I wrote on operations research. But it's the only one I started at the Boeing Company. Publishing things wasn't really on my mind at the time until I got to NPS in 1970.

BOB SHELDON: Did you teach yourself probability theory?

AL WASHBURN: No. I forget how I learned probability, but I learned stochastic processes from Don Gaver. And by tremendous coincidence, Don Gaver, my teacher at Carnegie Tech, subsequently went to NPS. So we are now colleagues. He has yet to retire—I'm going to retire before he does.

LEE DICK: Did he go with NPS before you did?

AL WASHBURN: After.

BOB SHELDON: What did you do on the commercial side for Boeing?

AL WASHBURN: Boeing, at the time, was interested in solving economic problems for carriers—it occurred to somebody that it would be a good idea to develop an economic analysis capability for airlines, so they didn't all have to do it individually. And I guess Boeing could put their own little spin on the economic analysis. But we had a genuine economic analysis capability. I can remember lots of problems involving calculating present values because, of course, that's the airline problem in that the revenue is always in the future. I did present value computations in the face of randomness and taxes. The taxes end up influencing your decision making.

I also worked on inventory problems involving aircraft parts. There are a lot of inventory systems that successfully get things into inventory, but there is also the problem of how to get them back out when they become obsolete or demand goes down. So I was working on how to accomplish that.

I also worked on finding niches for individual aircraft, the dimensions of a niche being capacity and efficiency. Where can you find a niche for a new aircraft, what should the production rate be, and questions like that.

BOB SHELDON: What motivated you to leave Boeing?

AL WASHBURN: I left in 1970. That was one of those years where there was a sign saying: Will the last person out please turn out the lights in Seattle. I guess Seattle doesn't have such strong boom and bust cycles any more, but 1970 was a particularly miserable year. We got to doing increasingly silly things, I felt, in the commercial airplane division. So, given that I was developing some academic proclivities, I started looking around and eventually joined the Naval Postgraduate School, where I've remained ever since.

LEE DICK: Was that in response to an advertisement or did you have a connection at NPS?

AL WASHBURN: If I had a connection, it was through Richard Duffin.

LEE DICK: Who from NPS interviewed you?

AL WASHBURN: Jack Borsting, the guy who hired me. Neagle Forrest showed me around the peninsula, and I gave a little talk on one of the problems I'd been working on at Boeing. I guess Jack liked the idea of hiring somebody who had been working for a defense contractor for awhile. So they made me an offer.

BOB SHELDON: What courses did they throw you into?

AL WASHBURN: The first course that I taught was the introductory probability course. I don't recall doing very well at it. Teaching doesn't come naturally to me. I have to work at it.

LEE DICK: You'd certainly honed your skills by the time I came through.

AL WASHBURN: Well thank you. Everybody doesn't agree with you even yet.

BOB SHELDON: Did you have some research topics that you carried with you?

AL WASHBURN: Yes. When I first got to NPS, I think the first proposal I wrote was to the Office of Naval Research (ONR) to continue work on pattern bombing problems of the type that I had been working on at Boeing. At Boeing, the patterns were caused by the fact that you have one ICBM with many warheads on it. And since you don't know where the ICBM is going, therefore there's a bias to all the warheads. They all more or less hit the same spot. So I worked on an extension of that. That problem never seems to go away. It arose most recently last quarter in connection with an artillery problem, shooting in the face of a common error.

BOB SHELDON: Did you have any notable students your first year of teaching?

AL WASHBURN: I remember P.C. Lui, who is a now the chief defense scientist for Singapore, in addition to several other titles. NPS has had a strong relationship with him since he graduated, including several educational enterprises. Bob Bliss was my first section leader, bless his heart.

BOB SHELDON: Probability was the first course you picked up. What other courses did you pick up during your first few years?

AL WASHBURN: At the time, we had a quite strong Ph.D. program. We may have had at the peak half a dozen Navy officers enrolled full-time to get a Ph.D. So we could develop courses intended for Ph.D.s, an unusual situation at NPS. I developed a course called *Control in Economics*, and taught it once or twice.

BOB SHELDON: Control and economics, how do you combine the two?

AL WASHBURN: Optimal control theory as applied to economics. Some economic problems have a strong time focus. The question of how fast Boeing ought to produce aircraft is an example.

BOB SHELDON: Who took that course? OR majors?

AL WASHBURN: OR, yes. I don't believe anybody but Ph.D. students took that course. Nowadays, in our department at least, the Ph.D. students are mixed in with the masters students. We have to justify courses on other grounds.

LEE DICK: Tends to be onesies and twosies.

AL WASHBURN: Yes, there's never enough Ph. D. students around these days to constitute a section by themselves. We could do reading courses, but this was an actual stand-up formal course with homework and everything.

BOB SHELDON: What kind of publications did you start working on at NPS?

AL WASHBURN: My second publication and my first one at NPS was ''Upper Bound on a Pattern Bombing Problem''—the result of that work for ONR that I just mentioned.

BOB SHELDON: Was that unclassified?

AL WASHBURN: Yes. I guess I have made maybe two classified publications in my life, not many.

BOB SHELDON: The first two of yours were published in refereed journals?

AL WASHBURN: Yes, the first one in *Operations Research* and the second one in *Naval Research Logistics (NRL)*.

BOB SHELDON: How did you find the referee process for your first couple of papers?

AL WASHBURN: That's interesting. I still remember one referee's report on the first *Operations Research* paper. I was, of course, a very young man at the time and completely unknown. And the referee looked at it and saw that the result was important and therefore concluded that the proof must be wrong. His review essentially said that it would have been shown long ago if it was correct. I was devastated, but we eventually worked it out satisfactorily.

Another paper concerned a game-based idea called Blotto games that I had worked on

at Boeing. In Blotto games, there's a bunch of individual battlefields, which at Boeing, would have been individual ICBMs under attack. And there's a contest over the battlefields. One side is trying to attack and the other defends. At each battlefield, the results of that battlefield depend only on the number that comes from the attacker and the defender. ''Majority rules'' is the simplest case. The fascination of the game comes from the fact that neither side knows how the other side is going to allocate its total number of attackers or defenders. If I know you are allocating 10, I will allocate either 11 or 0, but I can't predict what you are going to do. Mixed strategies result. I did some work on the problem at Boeing and offered it to *Operations Research*, but never got a reply until I got down to NPS, at which time I got a letter from Hugh Miser saying he had just inherited the job of being editor. He found my paper way down at the bottom of some stack where it had apparently been lying ever since I submitted it. That bothered me a little. But otherwise, I've found that the refereeing process is very instructive and helpful. It's always nice to find out about mistakes before they are published, rather than after.

BOB SHELDON: In your early study of nuclear exchanges, did you ever encounter Lieutenant General Glenn Kent?

AL WASHBURN: No, I didn't, but I can remember a trip to Washington with Jay Miller, my boss at Boeing. He used to talk about General Kent a lot. At the time, I was just down there in the weeds working away on things and didn't talk to generals. I just wanted to do my math. My first real contact with General Kent was in producing the 50th anniversary issue of *Operations Research*, which included an article written by him.

BOB SHELDON: When did you go to your first MORS symposium or ORSA symposium?

AL WASHBURN: It would have been an Operations Research Society symposium in Los Angeles when I was at Boeing. I came down with co-author Gene Shilly, a colleague at Boeing.

BOB SHELDON: What was your perception of the ORSA symposium?

AL WASHBURN: Sort of intimidating. There was just too much going on. Even at the time, it seemed big to me and much of it I didn't understand. Interesting and challenging.

BOB SHELDON: Did you continue to attend a lot of ORSA symposiums or MORS when you got to NPS?

AL WASHBURN: Both. It tailed off later in life, but for a while I was quite faithful.

BOB SHELDON: Did Jack Borsting twist your arm to go to MORS symposiums since he was one of our leaders at that time?

AL WASHBURN: No, I don't recall Jack twisting my arm. He just watched and corrected, but didn't twist much. That's not the style that I recall.

BOB SHELDON: Who were your colleagues that you worked most closely with at NPS when you were first there?

AL WASHBURN: I worked closely with Neagle Forrest. He was, at the time, the search theory guy at NPS. I should mention that, in a sense, I replaced Steve Pollock, who left for Michigan at about the time I came. Steve had been interested in search theory before he went and so I felt there was a hole there in the search theory world. And that perception of a hole, perhaps, is part of how I got involved in search theory to begin with. I saw the hole and there was a need for somebody to teach the course, so they said, ''Washburn, why don't you do it?''

BOB SHELDON: Did you teach yourself search theory?

AL WASHBURN: Yes.

BOB SHELDON: What did you use to teach yourself search theory?

AL WASHBURN: OEG56, the seminal publication from the Operations Evaluation Group (OEG). At the moment, I'm still working on a problem that involves OEG56. Bernie Koopman and others did some pretty good stuff back then. There were also some results in the literature, and notes from Neagle Forrest and others.

I eventually accumulated so many notes myself that I didn't know what to do with them all, and it was at that point where I wrote *Search and Detection* with John Kettelle as editor. In fact, John took the photograph of a needle lying on a haystack that was on top of my book. Subsequent to that, many years later, I saw another book on a completely different topic about searching for bugs in computer programs, or something. I forget the exact topic, but they used the same device on the cover, a haystack with a needle in it. So I made a copy of the cover and I sent it to John

along with a letter containing one sentence: ''Sue the bastards.'' I waited several weeks, and began to wonder whether he had actually gotten the letter.

Then I got a call from one of the secretaries in the OR department. Would I please come, quickly if possible, and pick up a box that had been shipped to me in the U.S. mail. So I went down to the department office and there was this Tide box sitting there. It didn't have any Tide inside it, but it recently had, which was why everyone was so anxious to get it out of the office. And it wasn't wrapped it up in brown paper or anything. It turns out that you can take a Tide box, put it in the mail, and they'll ship it if you have it labeled properly. I took the tape off to see what on earth could be in there.

It was from John, and it was full of hay, plus a set of instructions for finding the needle. The instructions begin, ''Take the hay, divide it in two parts. Sit on one half. Does it hurt?'' And it just went on like that. It was just beautiful. He's still very active, and retains his sense of humor. The last e-mail that I got from him had the subject line ''Not dead yet.''

BOB SHELDON: Did you have any Navy research projects on search theory that you worked on while you were teaching that course?

AL WASHBURN: ONR supported me to do some research on barrier patrols, which was subsequently published in NRL.

BOB SHELDON: Did you meet Bernie Koopman?

AL WASHBURN: Yes, I did. At ORSA meetings. Shook his hand, listened to him give a talk about the old days.

LEE DICK: It was certainly an awfully good course by the time I came through. Steve Pilnick talks about search theory as being the oldest OR class. Can you validate that?

AL WASHBURN: I don't know. But I do know that making any kind of a record statement about OR is a risky business. For example, there's a question of who has the oldest OR program in the country—that may or not be NPS. I've been arguing about it with Dave Schrady for years. We, in a sense, had the first ''program'' but then we wouldn't call the graduates Masters of OR. We just called them Masters of Science. The name of the degree took quite a while to change.

BOB SHELDON: One of the courses you taught was Kalman filters. How did you pick that up?

AL WASHBURN: It's a course segment, rather than a course. When I discovered Kalman filters I thought they were a particularly beautiful concept, a simple idea that does something sophisticated through repetition. I felt that our students were already doing all of the foundation material required to get there and so why not finish it and teach them Kalman filters.

BOB SHELDON: Which course did you put that in?

AL WASHBURN: I put it in our second stochastic models course, but more regularly I put it into our course about tactical decision making. Not that it particularly belongs there, but it does work out nicely there because so many undersea warfare (USW) students take it, and Kalman filters have a lot of USW applications.

BOB SHELDON: How about your thesis students that you supervised? Any noteworthy?

AL WASHBURN: Many noteworthy, but one on Kalman filters comes to mind. That was by Pete Daly.

BOB SHELDON: What aspect of Kalman filters?

AL WASHBURN: One question that Kalman filters can be applied to is passive ranging, the old business of measuring bearings and trying to figure out the range of the thing that's causing all the commotion. Pete Daly's was on that subject, figuring out how well Kalman filters do compared to other techniques, whether they have biases and that sort of thing. The trouble with passive ranging is that you have to use an extended Kalman filter because the relation between state and measurement is nonlinear. There are various kinds of embarrassment that can happen when using extended Kalman filters, and Daly's thesis explored whether they actually happen in practice. I've advised about 75 master's theses and two doctoral theses: Takasi Kisi and Kirk Yost.

BOB SHELDON: How were the master's students to work with on the thesis projects?

AL WASHBURN: Our great advantage at NPS, and I think the reason why we still have master's theses, is that our students are mature. They've been out there and they know what the problems are. That is a tremendous leg up on doing a thesis. Without that maturity I think

we'd just abandon the thesis requirement because theses do take time, and if you can't convince yourself that there's a lot to be said for them, you'll either shorten the curriculum or put more courses in. I'm still very much a supporter of theses, but I think I would not be except for the fact that most of our students have the experience required to work on them. We have these days a fair number of students who come directly from the Naval or the Air Force Academy. A thesis with them is a bigger problem because they don't know what their service's problems are yet. They've got the analytical capability, but that isn't sufficient.

BOB SHELDON: Which of your master's theses that you supervised had a tangible impact on Navy operations?

AL WASHBURN: One of the first ones, this would have been in the 1970s sometime, was by Long, Cushing, and Gautier. They did a simulation of the introduction of the LM2500 gas turbine engine into the fleet. That's the engine on the DD963 class and other ships. Such engines don't always stay on the ship, since they need maintenance like everything else. The idea was to establish a rotatable pool where one trades in an engine needing maintenance for one that doesn't. The question was how many engines do you need in the pool as the ship numbers gradually build up? These students discovered that the size of the pool had been conservatively overestimated. They figured that a smaller pool of engines would do and saved a bunch of money. They all got credit for that and I got some reflected glory, too, which is always nice for assistant professors.

BOB SHELDON: Why the gradual change at NPS to getting more students straight out of college and fewer who are working first before they come there?

AL WASHBURN: That's not gradual, that's sudden. They were fairly common when I first got to NPS and then the practice died out in the intermediate years and now it's come back again. I'm sort of two minds about the idea as you can tell with my feelings about theses. On the one hand it's nice that they come directly out of school because they haven't forgotten probability yet, which older naval officers typically have, if they ever studied it in the first place. And calculus doesn't need to be refreshed if you come straight out of school.

But there are disadvantages. It does pay to have some real-world experience before studying OR. The thesis problem also sometimes comes up with foreign students. Some of them have the advantage of having been operational, but it is sometimes operations on problems that the faculty are not familiar with. Alberto Soto's thesis concerned operations of Chilean diesel submarines. I started off not knowing about diesel batteries and stuff like that, so to some extent he was advising me, instead of vice versa. I'm glad he was a thesis student, but I started out not being able to advise him very well.

BOB SHELDON: Did you ever get out on a sea cruise to see the operational side of the Navy?

AL WASHBURN: I have been out of Monterey on several occasions, spending quarters in various places. I spent a quarter at Third Fleet when they were still in Honolulu. More recently, I spent a quarter at Third Fleet when they were in San Diego. It was at that time when I went out with the *Constellation* on an antisubmarine warfare (ASW) exercise right before she deployed to the Gulf. I got to spend four nights on the carrier, pretending to be from the Center for Naval Analyses (CNA) as part of a reconstruction team. That was really an eye-opener. You know the biggest eye-opener, what I discovered about military life? The biggest thing that shocked me is that it's 24 hours a day, seven days a week. It never stops if there's combat. I normally think of life as nine-to-five, but that's not the way it is if somebody's shooting at you.

BOB SHELDON: Were any of your former students on the ship?

AL WASHBURN: Yes. In fact, one of them was a USW student, the P-3 liaison officer Dave Hauth. P-3s were active all the time, but there was only one of him. He had been up for, I think, 36 hours straight at one point and he still wasn't headed for bed. These get to be big human factors problems, when you have somebody with a rare expertise that needs to be up all the time. I also got to see how people really do passive ranging, which is stunning in itself. That experience has motivated some subsequent theses.

BOB SHELDON: Any other research projects out of your fleet visits?

AL WASHBURN: Several. I also spent quarters at the Keyport torpedo station and at the Naval Telecommunications Command

in Washington. The Third Fleet visit in Honolulu resulted in one of the few classified things that I've written—the basic problem there was that there were only 32 sonobuoy frequencies, so sonobuoys were sometimes interfering with each other. Sonobuoy tactics had to deal with that. I generated a TAC Memo (Tactical Memorandum) on the subject.

BOB SHELDON: Were your study recommendations implemented?

AL WASHBURN: I don't know. It was subsequently overtaken by events because they went from 32 to 99 channels, and the interference problem basically went away. I also spent a quarter over at La Spezia, Italy, at the SACLANT ASW Research Center. That resulted in a NATO confidential study concerning antisubmarine warfare in the southwest approaches to the English Channel.

BOB SHELDON: That was in Naples?

AL WASHBURN: La Spezia.

BOB SHELDON: Did you enjoy life in Italy?

AL WASHBURN: Loved it. I took both my kids Amy and Andy with me. They were 12 and 14, or some numbers like that. They both loved it, as did my wife Anne. She would go down to the market and speak Italian in her own way, which is with the hands. That's my advice for traveling in Italy: learn the hands first and the mouth later.

BOB SHELDON: At some point in your career, you picked up an interest in C4ISR. How did you start researching that?

AL WASHBURN: I guess Kalman filtering led in that direction. I wrote that article in *PHALANX* on ''Bits, Bangs, or Bucks.'' That was a skeptical approach to the subject, about how well we do or don't do at analyzing problems involving information.

BOB SHELDON: You had one article that was published recently, on nuclear exchange.

AL WASHBURN: That's a return to my first job at Boeing, actually. The anti-ballistic missile (ABM) allocation problem has returned.

BOB SHELDON: Did somebody prompt you to do that? Or did you just pick that topic on your own?

AL WASHBURN: I picked it on my own. That was unsupported research.

BOB SHELDON: Have the courses you've been teaching stayed about the same or do you teach new courses?

AL WASHBURN: I often teach new courses. The most recent is our new, second-quarter decision theory course. It's basically Bayesian decision theory, designed to reinforce probability and the connection with quantitative decision making. I have taught that a couple of times now. I also teach a video-teleconference course, or VTE, I guess we're calling it. Video tele-education. It's for a different curriculum (PD21, rather than OA), but a similar subject. Both courses involve probability and decision trees and influence diagrams.

BOB SHELDON: Do you teach the value focused thinking, also?

AL WASHBURN: Decision theory is focused on values, and you really can't get anywhere without some kind of a utility function. I guess the answer is yes.

BOB SHELDON: Did you ever meet Von Neumann?

AL WASHBURN: I'm sorry, I did not. Our lives overlapped in time, but not professionally. Such a brilliant man.

LEE DICK: Have you ever worked with Dan Wagner?

AL WASHBURN: Yes, I have. Dan was on the faculty at NPS for a while. It was while he was on the faculty that he wrote his notes on tactical decision aides that I still use in our tactical decision making course. He largely incorporated those notes into *Naval Operations Analysis*, the third edition of that book. Dan used to play in our poker game—we have had a weekly poker game out there going on since about 1968.

LEE DICK: Applied probability theory?

AL WASHBURN: That's right. Dan had a game called Lollapalooza, which he would announce every now and then and we'd have to play.

BOB SHELDON: And the Dan Wagner Associates are still around?

AL WASHBURN: Oh, they sure are. Dan Wagner Associates and Metron, a spin-off from Dan Wagner Associates, are still very active in search theory and other topics. I refer to their work constantly in the tactical decision making course that I teach.

BOB SHELDON: When did you first start attending MORS?

AL WASHBURN: When did it start?

BOB SHELDON: 1966.

AL WASHBURN: I can't remember when I started. It's always been an activity. MORS meetings are particularly nice because they usually happen during one of our two-week breaks, sometimes conveniently located at NPS. There's enough space at NPS to host a classified symposium.

BOB SHELDON: Do most of your thesis students seek you out? Or do you recruit them actively from the classes?

AL WASHBURN: I don't recruit them actively. If they express interest in a topic, I'll be happy to encourage it, with rare exceptions.

BOB SHELDON: You've done some non-Navy research. Can you comment on that?

AL WASHBURN: I have done some research for the Air Force that was related to Kirk Yost's dissertation. It was basically the same topic, the Linear Programming (LP) - Partially Observable Markov Decision Process (POMDP) marriage, trying to design software that would be useful for automatic air tasking order (ATO) generation. The idea still appeals to me, although I haven't succeeded getting it implemented yet. The Air Force has supported me before, too, and I've been supported by the Army to look at command and control issues.

BOB SHELDON: You mentioned one of your earlier students who made high rank was from Singapore. Any other of your students who went on to fame and fortune?

AL WASHBURN: Pete Daly is a three-star admiral.

LEE DICK: Thirty-five years at one location is a long time. Were you ever considering leaving NPS or was that never really an issue?

AL WASHBURN: I was never unhappy at all. I like NPS and Monterey. There's been quite a bit of variety in the job in spite of spending 35 years with one employer. I earlier mentioned several quarters spent away from Monterey, and I also spent a year on sabbatical in Scotland.

BOB SHELDON: What did you do in Scotland?

AL WASHBURN: I was at the University of Edinburgh, with my host, Lyn Thomas. Lyn has since moved to Southampton, but remains a good friend.

BOB SHELDON: Did you teach a course?

AL WASHBURN: I did not. I gave the occasional lecture on search theory, but nothing resembling a course. I did a little work for ARE, the Admiralty Research Establishment. But mainly I was just letting NPS pay my salary half-time to sit over there and think great thoughts.

BOB SHELDON: Produce any papers out of that?

AL WASHBURN: Yes, Lyn and I wrote a paper on the flaming datum problem, which is something that's been occupying me for a long time. And I started on a couple of things that I never completed. They're still lying on my desk, I'm sorry to say.

BOB SHELDON: What inspired the flaming datum?

AL WASHBURN: It was an effective kind of ASW in World War II. If a submarine doesn't want to shoot anything, it will never be found. Your best chance of getting the sub is right after he shoots something himself, in which case a flaming datum marks the place where a sub once was. If one is going to take ASW seriously, one ought to be able to take advantage of such situations.

LEE DICK: Did that develop into a TAC Memo?

AL WASHBURN: No, it hasn't.

BOB SHELDON: I'd like to give you a chance to comment about your students and the OR field and what your interests are when you retire. Wayne Hughes says you don't have to retire. He says you can stay if you want.

AL WASHBURN: He better say that. He's retired four times himself by now. It is my intention to retire at the end of this calendar year. I don't know what follows, but I don't expect to abandon NPS. I'll go down there and happily play with my toys and cooperate in some research projects, although I do expect to mostly get out of the teaching business. I will also go fishing.

LEE DICK: Any comments about OR as a field of study?

AL WASHBURN: I think it's a great field if you have a proclivity in that direction. I expect the employment picture to look increasingly bright, but the main question ought to be whether OR appeals to you. Everybody doesn't get the same kick that you and I do out of quantitatively capturing the essence of a problem and figuring out how to make things better.

BOB SHELDON: Are you contemplating writing any more books?

AL WASHBURN: No, although I'll probably update the two I've written. Oh, that's not

true, I do plan to write another book. It will be a book on military OR, which I'm writing with Moshe Kress and Tom Lucas. That's one of my retirement activities.

BOB SHELDON: What will be the orientation of the book? Tom Lucas is a statistician.

AL WASHBURN: He's also a combat simulator. I think that will be his main contribution in this book that we're writing.

BOB SHELDON: Who is your target audience?

AL WASHBURN: We have to work that out. I suspect it will probably be graduate level, but we do plan to have exercises in it, so it could be used as a text. You'll have to know how to differentiate when you pick it up, and I think you will also have to know what probability is. Spreadsheets will be included with the book. I'm excited about working on it.