An Interview with

JAN RAYCRAFT

OH 509

Conducted by Thomas J. Misa

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Abstract

Jan Raycraft grew up in northern Minnesota and graduated in 1980 from the University of Minnesota-Duluth with a double degree in biology and chemistry, gaining valuable experience in FORTRAN programming. (She later in 1987 received a master's degree in mechanical engineering from the Naval Postgraduate School.) Direct from college she was recruited into an engineering division of the US Navy, serving as engineering duty officer (1981-2001) in Long Beach CA, Sturgeon Bay WI, and Annapolis MD in a variety of ship repair, ship inspection, managerial, and teaching roles. She vividly relates her experience supervising shipyard workers and the strategies she used to win their trust and confidence. Her experience teaching naval cadets in Annapolis affords her to offer comments on men and women naval midshipmen and gender-role expectations in a military setting. She moved from the Navy to Lockheed Martin in 2001 and worked there for 11 years as a program manager. In this setting, she describes elements of Lockheed Martin's corporate culture, interactions with Navy customers and computer vendors, and her shifting activities as Commercial Off The Shelf (COTS) computing became the norm.

Misa: My name is Tom Misa and I'm here — it's the 9th of November, 2015 — with Jan Raycraft at her offices at PDA. This is an interview for a project we're doing for the Sloan Foundation, interested in the perspectives and experiences of women who were working in the computer industry from the 1960s to the 1980s. And, Jan, if I could start with your childhood and your experiences growing up; a specific question would be if there were areas of particular interest or activity maybe in grade school or high school that lead you to be interested in a military career but also a career that obviously had a strong technology component.

Raycraft: Okay. I'm trying to remember; when I was kid I just I liked puzzles, solving things that were more technical. My undergrad is in biology and chemistry, so anything that was science was the line I was going toward. I wasn't really anybody active in sports; course there weren't really a whole lot of sports offered to girls at that time.

Misa: Big difference today.

Raycraft: A big difference today, right. I grew up in a place, a small town in northern Minnesota, in Virginia, Minnesota.

Misa: Virginia.

Raycraft: Yes, Virginia, and we really didn't have a whole lot, you know, so my mom and I pretty much grew up together because my father passed away when I was young. I

was in the orchestra and things like that. I'm trying to remember. I liked math, I liked those types of subjects so when I went into college, I first started to become a biology major, interested in just well, more cell structure and things like that, which kind of was a good intro into chemistry. Chemistry was kind of an add-on because of computers; FORTRAN. [Laughs.] FORTRAN programming was a requirement, I think, of both biology and chemistry at the University of Minnesota in Duluth. There I met a good friend, who was a chemistry major. Next thing I knew, her and I were in. She talked me into taking a couple other courses in chemistry and next thing I knew I was a double major. It was one of those things; the FORTRAN brought us together.

Misa: Did you have any computing experience in high school? Some people did, but not all.

Raycraft: No, none whatsoever. In fact, I remember taking all the more challenging courses in math in high school, but they didn't have anything with regards to computing. In fact, I remember we were using slide rules. I remember getting my first calculator when I was a senior in high school and the thing that I remember so vividly is because I was in a very accelerated physics course and we were doing horribly long mathematical equations, right before Christmas. I was on the phone until 2:00 in the morning with friends trying to compare our numbers.

Misa: This is still in high school.

Raycraft: In high school, we were trying to get this done. My mom was in bed thinking should I give her that calculator for Christmas now? Or should I wait until Christmas morning? Well, she waited for Christmas morning so needless to say, I couldn't use that calculator, which I could've really used that day. And here it was nothing more than a real chintzy one that you could probably get for a couple bucks nowadays, but it was expensive for her at the time. We had very little money so she wanted to save the big gift for Christmas. And then after that, I never had a course quite like it. I mean, next semester it wasn't nearly as intense as that semester right before Christmas. So we didn't have any type of computing or even knowledge of how computers [worked].

Misa: You had science courses, though. Some of those teachers must've made some encouragement toward your pursuing a science or math background.

Raycraft: I think that because the math came more naturally to me. English was okay, and history, but math was like a puzzle. Math was like trying to find things. When I did start my FORTRAN classes, I did enjoy that because it was an if/then, okay, you know, these loops that you had to make, the logic of that was kind of fun when you finally got it to click. But we had fun with all the old punch cards and things like that, that you had to put in. I enjoyed it a lot. I don't even remember thinking of computer science as another major at the time because I was just so entrenched in my biology classes and going into some chemistry, that it just wasn't an option, or I didn't vector off, even though I did enjoy it when I was going through there. That's why it's kind of hard for this study that I know that you're looking at, is finding out the going into it because at that time when I

graduated high school in 1976, and of course, got out in 1980, which was when I graduated with my double major.

Misa: That's pretty good to do two majors in four years. Must have worked hard.

Raycraft: Yes. I actually went extra semesters, so I actually [graduated] in December, it wasn't in May. But it was my chemistry, really, I think, that was the carrot that the Navy saw because I ended up getting a call from a recruiter. I had no intention of going into the military; I didn't know anything about the military when I was getting out of college. It just so happened that somebody called me, and it was Christmas, and I was going to hang up but it was Christmas so I said okay. I just listened to this guy for a while and the next thing you know, he had me actually go out to D.C. to interview with Admiral Rickover.

Misa: Really?!

Raycraft: Yes. [Laughs.] The father of the nuclear Navy was forced to start interviewing women, and he did not necessarily select them but he had to at least interview them. And because of my degree in chemistry, and the technical nature, they wanted me to teach in Orlando at the nuke power school. That was my only career path. There were no women on anything. We had nuclear submarines or surface ships, at that time. I didn't realize it but it was a dead-end career. You could teach for about as long as six years in the Navy and then you had to transfer to another career or get out. But they didn't tell me that; a recruiter would never tell you that.

Misa: Did you have ROTC or anything as a college student?

Raycraft: No. [Laughs.]

Misa: So they were just recruiting you straight off [pause]

Raycraft: Some recruiter went to University of Minnesota Duluth, went through transcripts and just made cold calls. And the cold call happened to come at Christmas and I was like ooh, okay, I'll listen. I was trying to find a job in just my strict sciences, which is not easy, you know, when you just have a degree in a technical field.

Misa: What other things might you have done? Totally hypothetical, but working for a lab? Or working at the University at Duluth?

Raycraft: I had a job offer working for the Environmental Protection Agency in Duluth. When I went in there, the job description essentially would be; they were concerned about the asbestos fibers in Lake Superior at that time frame, and so they would inject rat lungs with these fibers and send them — I think they were done somewhere down in the South — and the lungs would come back to Minnesota, and there was an electron microscope that I would be responsible for preparing the lungs on the electron microscope and then sorting and classifying the fibers in the lungs. So that was the job offer; as well as you could go into the Navy, and see the world, and do all sorts of crazy

things. So it was like rat lungs and electron microscope, or the world, you know? It's like um, okay, I think I'll take the world. [Laughs.] So that's what I did. I decided I'd go out and do all these interviews and see what I had to look forward to.

Misa: So what was Rickover like? He was quite an imposing character.

Raycraft: He was extremely tiny, but it was a grueling process. They bring in maybe 60 people at a time. It was, you know, a certain month; and you know he hand selected all of his officers. And because I had a college degree, they wanted me to be an officer in his program. So they bring you in — you had to go to Washington, D.C. for this whole thing — and they talk to you, and you don't know who you're talking to; it could be a technical person, or it could be a psychologist trying to get your flavor for that; you just wouldn't know. So you go through a serious of maybe some technical interviews that weren't maybe technical interviews; you could go through a test; I mean, the whole thing was taken up with meetings that somebody randomly selected what your schedule was. And in Washington, D.C., and the NFCOA, all of the hallways had to be keyed. It was kind of a secret area and very well controlled. It was funny because when they brought you in there you didn't know what you're going to be faced with, and they start talking about ladder wells, and bulkheads, and heads, and all this. What language did I just join? It was all Navy language that they were using to you. But you didn't see Admiral Rickover until the end of whatever process you had been screened for. Some people went through that process very quickly; I, unfortunately, was at the last, the very end of the day, because it was like five o'clock at night. I remember doing a lot of interviews. I didn't have the test

but I had to wait in the outer office, and then they treated you like okay, it's like a football thing. Okay, this is the outer office, and you have to walk through this thing, go in through this thing, and you go into this office, and you sit down in these chairs, and they had them marked with a big "X", and you sit down there and then you just wait. And at that point, you don't say one word, you only speak when spoken to; and you're always with another officer. At that time, in the early 1980s, officers in the nuke power program at that time did not wear their uniforms in D.C. so they could not be distinguished [as] an officer or a civilian.

Misa: Yes.

Raycraft: So an officer escorted me into the room, and the admiral was sitting there and he was so tiny, and he was so old. It was about six months or so from his retirement date, his forced retirement date. He just kind of looked at me and he goes, why do you want to be in the Navy? Then I was married and he asked what my husband did. I don't even remember if there was a third question, but you could tell he had no real interest; he was going through the motions. At the end he said that's all. I didn't catch it, but the guy next to me jumped, I jumped and just ran out of the room. [Laughs.] And that was it. Then you sit and just wait. Then they said Admiral Rickover didn't select you. I'd never been not selected for things so it was kind of like a real blow. Then he said but we have engineering duty officer, they also do interviews. I looked at them and said what's this thing going to be? Because they never mentioned it before; and later I found out that recruiters have point values. If they can get you in nuke power, that's the most points,

that's great for the recruiter. If they can get you in engineering duty, which is another very restricted community, that's better; it's a pecking order is what it is.

Misa: So depending on prestige or something, recruiters get certain [pause]

Raycraft: Yes, different points. So I looked at him and he says well, it's a community of probably around 1,000 officers and they hadn't really had women in that community yet. It was very few; they just were starting to integrate them maybe about five years before that, and what you're responsible for was more of the acquisition of ships' design systems, and you would go into ship yards, or supervise a ship building. And you're kind of a manager over a number of civilians and you could be involved with being in charge of a whole overhaul of a ship, you could be in charge of new construction of a ship, you could be in charge of giving them direction. You are responsible for the money and going to Congress and getting the acquisition of what your budget is.

Misa: It's a big and complicated job, then.

Raycraft: It's a very, very complicated job. And not many people are allowed to do this, and very few at that time were women. And they said that they would want to interview but unfortunately they were not able to do the interview that particular month because the schedules just weren't working. So they said would you like to come out next month? I'd never been on an airplane before and that was kind of fun, so sure, I said, I'll try it again.

Misa: Okay.

Raycraft: So off I went the next month, and it was a totally different environment because these people were now trying to recruit me into the community. So [each] interview that I went to was very supportive — this is what we do, or in charge of doing this — and I'm looking at it like wow, this is a big difference from trying to get into the other, because they really didn't have many women that were willing or able, at that time, to go into; you would go in as an ensign and you would be designated as an engineering duty officer, a 1440 designator, and then that is your career path. They would continue putting you from one easy job into another and every career path is a little bit different. So I was listening to most of them except for one, whose name was Captain Fierbal, who later when I ran into him again, was Admiral Fierbal, and he was more of the Rickover type of person. So his first question to me was well, how does an airplane fly? Excuse me? You know, how does an airplane fly? I'm a biology/chemistry major who looked at him like I don't know what you're talking about. He says, you know, Bernoulli, Bernoulli, yaddayaddayadda; and I looked at him like still not cutting it here. So you moved on and we were alright, and he started telling me about what a tough environment it would be in the shipyard, and said have you ever seen the movie "On the Waterfront" with Marlon Brando? And I said nope, not really. [Laughs.]

Misa: "On the Waterfront," okay, that's his image of this job.

Raycraft: Yes. That's his image and I looked at him like no, I really haven't. And he looked at me again like oh my God. Then we talked a little bit more and that was the end of the interview. The next thing they did is that you would be brought in front of an Admiral and the engineer duty officer community, and my Admiral was Admiral Beecher.

Misa: You had contact with some high level people.

Raycraft: Oh yes. They wanted to really screen people into these communities. This wasn't just going into the Navy, this was going into specialized communities of the Navy. From my Rickover days; the thing they told you is if Rickover asked you a question and you could not answer the question, you're obliged to write him a letter on what the answer is after you've done your research. I thought, well that guy's probably wondering about what about this Bernoulli thing, so I just said well the library's open during lunch so I went down, I looked at this book and I found the Bernoulli formula and I didn't know really what it was saying on it, but I copied it down, I figured that's how an airplane flies; it gives you your lift and thrust, and okay, so I wrote it down. I wrote a little note and went back up and he wasn't there, he was at lunch. If you could give this to him; I gave it to his secretary. Well, when I went in to talk to Admiral Beecher, sure enough, there was my letter and my note; comment that down at the bottom we could maybe teach her. So they allowed me to go into the EE program and that course of; essentially at the Navy is through Officer Candidate School, so it's a four-month program up at Newport, Rhode Island. There you go through all the basic training type of stuff,

but a very accelerated course, so when you were done after four months, then you're actually assigned to whatever Navy job that they select; whatever ED job is going to be there.

Misa: So you started out with this engineering duty, did OCS try and come back then to the engineering field?

Raycraft: Yes, that's your designation. You're going to school there with people that are going to go on surface ships, they're going to be surface warfare officers; they could be submarine officers; they could be aviators; they could be supply officers, civil engineers; you don't know where all these people are going to end up but they all have to go through the same course if you did not go through ROTC or one of the service academies. That's your only other option to get into the Navy. So once I'd completed that, then that's when they sent me to Long Beach Naval Shipyard to be a ship superintendent. And at that time, we were overhauling and I was in charge of the overhaul of a destroyer. First they put me as like an assistant. I was an ensign, I was right out of college, I hadn't ever seen [pause]

Misa: These are really heavy responsibilities for a relatively young person to take on.

Raycraft: Yes, when you have a $7 million overhaul and you're in charge of it, and you have to deal with shipyard workers, and all these foremen, and you're responsible for reporting to the CO of the ship the status of the overhaul, as well as the shipyard commander on what your perception is of the work in progress, and you have to deal with

people that really didn't want to deal with a woman. It was still very much of a man's world, although they were being forced at the time. Long Beach was a public shipyard and so they had to go through public type of government restriction, you know, rules, so they had to start integrating women workers, so they had very few shipyard workers that were women at the time, and very few women that were engineering duty officers. There were only like a couple others that were there at the shipyard when I was there; it was mostly a man's world at that time. There were a lot of challenges at that point.

Misa: Could you describe some of that? It sounds like a really fascinating, unique experience for you to have had.

Raycraft: It was very interesting. [Laughs.] I mean, you're going into a situation where you know, all of the spaces that men worked in still had all the girly pictures, there were still the smokers, swearers, all sort of craziness going on. I was tagging along with another ship superintendent, Danielle, who was one of the guys. You know, she was a smoker and a swearer, and I was going oh man, I was just thinking there oh my — and born in Minnesota, you know — going oh my God! I was in awe of the whole thing. I'd never seen a ship before; I'd never been exposed to welders, sheet metal workers, machinists, electricians, all of the trades that are involved in shipbuilding [and] construction in general. My growing up, my dad had worked at a clothing store until he had passed, and my mom and I just were on social security where we really didn't get out much. We didn't even have a car until I got enough money to save up for one and then try

to figure out how to drive it. She was my copilot, you know, and she had driven before, but . . .

Misa: So the shipyard was kind of a rough and tumble world.

Raycraft: The shipyard was huge! It was very scary in a way, but slowly I came to the realization that you can't do your job unless you're you. You can't be somebody you're not. I was not a swearer, and I was not going to do that to do that job. If they didn't like it, oh well. But I was a listener, and when I was in the military I didn't like to pull rank, if you will. And I didn't have any enlisted people working for me at that job. I was a military person in a civilian world, which the only other military were other ship superintendents. They had a repair officer that was in charge of all of us, and then we reported to the shipyard commander, who was military. Military were in charge of various positions, like ComAd systems, planning, testing, you know they were only integrated in key positions into the shipyard to keep the civilians working and reporting. The reason for that [is] in the military was the fact that we would always rotate every two to three years, that was kind of like the thing. The philosophy was that we would keep challenging the civilians. There would always be somebody new that they would have to train up, but also challenge, and so that they would never become complacent with the same person always in charge. So your military was always bringing in fresh ideas, the challenges, whatever, but the civilians really who had done this for many, many years would still keep the stability in the shipyards.

Misa: They would've been, in some ways, the experts. You're not going to be more expert than a welder in that job.

Raycraft: Oh gosh, no. No, you never can be. But you can be somebody that goes and asks questions and brings people together, and gets people to communicate, which was their problem. There was no communication in the shipyard because you go into a trailer, where you would have these desks butted up, and you'd be in charge of an overhaul, and you'd ask about a job. Well, what about this job? It needs to be done. Well, I need a welder. Well guess what, here's Mr. Who Cares over here, he's in charge of welders, he can get you a welder. And they go, can you get him a welder? Yes. Oh, there you go; I got our welder here. And it was just things like that; you know, they could do whatever; a valve needs to get done. Well, let's walk over to the valve shop and see what's going on, and ask the person what's going on here? You know, you just get people talking, and you tell them; I was always the one who liked to tell why. Why were we trying to do this? What's coming up? There's a certain evolution in the schedule that we have to try to meet, and then this person needs to get done here, and they listened to me like then they kind of understood, okay now I see why we maybe we have to rush this portion and this portion can maybe lag a little bit more. But I also like to do by example. If I was in there and I saw something had to be done in the bilge, I'd get down in the bilge and grab a rag; I had no problem with wiping grease and oil. But through those, kind of showing I wanted to help. I wasn't like a special prima donna that was just there. I wanted to be a team member, I didn't want to be just a supervisor. The respect that I ended up getting was pretty soon people started telling me things instead of me having to ask about it.

They were realizing that if they told me, a lot of times I could get them the help that they needed to make their job easier, so that's why they started telling me different things. They respected my choice in not wanting to use colorful language, and they kind of stopped using it themselves when I would come in and we would talk. They felt like okay, she's not here to take my job away but to help it, and it was kind of fun. You know, we tried to make it more of a team. So when I ended up leaving the shipyard, I think I had probably the one of the biggest exit parties ever, because all the guys got together and they had a big party at the officer's club and I got a lot of various memorabilia when I left that they had had people make for me, and stuff like that. But it just shows that you had to [interrupted]

Misa: This is primitive man's world, though, wasn't it?

Raycraft: It was very much a man's world. My worst man's world was the time when I was put in charge of a ship overhaul, the *John Young*, and the CO pretty much hated me. He expected a Lieutenant Commander or Commander [and] I was an ensign being now in charge of his overhaul, that he demanded respect. We also were competing with the U.S.S. *New Jersey*, which was just coming into the shipyard for modernization. Ronald Reagan even came out and did things. I had this little ship with no clout, if you will, to get the people to keep the overhaul going. But somehow, we managed to get done on time and under budget — surprise, surprise — by just being perseverant, but the CO still hated me.

Misa: That's the commanding officer, not of the shipyard but of the ship itself.

Raycraft: Yes. He was a little bit prejudiced, as probably men in those types of roles [are]; maybe other things, too, but at least in those roles. The planning officer, even before I was given that assignment had told me, you better not get pregnant during this overhaul. It was kind of like well, we're putting you here, now we don't want you to — I don't know — like I said, some of the stigma of women in that time frame was that when things get tough, maybe they get pregnant to get out of things; or if they're pregnant, they can't do the job; or whatever. And so you get these little aside comments; you get different looks, like really, are you for real doing this? And you don't necessarily get the respect. You could say something and people don't really think the idea is good unless they hear it out of a man's voice. You go through all of that but it depends on how you reacted to it, whether or not you could still be effective or not. And I just found that just being honest, a hard worker, no expecting favors, just trying to do things, ended up eventually turning people around and realizing that she's not a bad person, she's honest, she's never done anything wrong, and they supported me 100 percent.

Misa: You said people do this job for about three years. Was that your experience?

Raycraft: Yes, I did my job at the shipyard for about three years. And then I went to the Naval Postgraduate School and got my master's [degree] in mechanical engineering.

Misa: Oh, okay.

Raycraft: So every engineering duty office had to have some sort of engineering degree at one point, and they want you to have a master's. You could go to Monterey, California at the Naval Postgraduate School, or you could go even to M.I.T. and my undergrad was not in engineering so I could've gone to any engineering field — mechanical, electrical, I'm not sure if computer science could've been another one — but I know that [pause]

Misa: Big computer science program, actually, at Naval Postgrad.

Raycraft: Yes, there is one there. I'm just not sure if it was sanctified by the Engineering Duty Officer community. The community had certain requirements that they needed to have fulfilled, so I could've gone to M.I.T. but I was so afraid that I didn't have what it would take to get through the program that I wanted, I thought Monterey wouldn't be as intimidating because everybody would be naval officers there, going through school. And so that's why I decided to take that route, and it worked to my advantage. I did well in that school. I ended up graduating as one of the top students in that time that graduated.

Misa: Wow, that's great.

Raycraft: And I ended up getting a little longer degree. It's usually a two-year degree but I went like two years and six months to get an engineer's degree, as opposed to just a master's degree. It was a crazy little; it's kind of between a master's and a Ph.D. that the Navy was offering. It gave me an "N" code as opposed to a "P" code and it meant

nothing later on, but it was a more extensive research project. And I guess now that I think about it, I did do a heat analysis in a submarine, pure programming [laughs], with somebody that was working at Notre Dame. We had a visiting professor from Notre Dame, K.T. Yang, that was at Monterey. When I was doing my master's I wasn't really sure if I was going to do it in material science, but heat flow wasn't really what I was thinking of, but one of my professors came up to me and said, did you ever think about doing this? Well not really. But he hooked me up with K.T. Yang, and he had a student in China that was at Notre Dame, and he was a whiz. He was like early 20s, getting his Ph.D., and his name was H.Q. Yang.

Misa: Oh, H.Q., okay.

[Laughter.]

Raycraft: H.Q. and I became friends, and he did most of the work, and I would just do some radiation factors of it, a small blip of his *major* programming that he had, but it was enough to do my thesis. So it all worked but I had to go and spend a week with him at Notre Dame, during summer; Navy Postgraduate School gives you a week off, or two weeks off in the summer, and then at Christmastime. So in that timeframe I would just go there and work with him. He was quite the character and he liked to work at night, and I'm a morning person. So we were kind of were like we gotta figure out a way; so he got up a little earlier and I stayed up a little later.

Misa: Okay.

Raycraft: But we worked at it all day long, to me it seemed like. We got along very well and I just had to kind of laugh because while his English was broken, but I always said his English was a heck of a lot better than my Chinese. [Laughter.] Like I would be working on something at work and I'd go oh, hot dog! And he'd look at me like what the heck? And I'd say it's just an expression. But we'd get along very well and I never saw the campus at Notre Dame until the very last night when I said you know, I never saw anything here because we worked all the time. Oh, I'll show you!

Misa: It's a pretty campus.

Raycraft: Yes, in the middle of the night we saw what was part of Notre Dame; and then in time, he came out to Monterey for a week to work on the program, and we would submit these big disks. He would mail them and I would bring them to our computer center where they would actually run the program for us and it would run all weekend.

Misa: Was it disks, not tape, but disks themselves?

Raycraft: I don't know. They were big disks it seemed like. It was in the early 1980s and I remembered that it would take almost all weekend to get just a few seconds of the actual fire. We would simulate a fire onboard a submarine and I had more computing capability at the Naval Postgraduate School than he did at Notre Dame for timing, because his was, well, not as sophisticated as what we had at Monterey, but also, there

was so much competition that they couldn't get a good block of time. And so he would send out what he was doing to me, and then I would bring it to the center and they would run it, and then I'd pick it up on the weekend and go through all these pages of data and try to figure it out. But you know, I'm trying to think back on it for why I would even think of that? Again, it was like a puzzle; it was trying to figure out ways; and the professor saw something in me that would be good to be able to do this type of programming.

Misa: There was a lot of math there, and it sounds like that had been an interest of yours for quite some time.

Raycraft: Yes, and like I said, I don't why math ever struck me, but it did.

Misa: That happens.

Raycraft: I just always did like stuff like that. But it was really strange when you think about it, because they put you through this intense school there to get your master's in some form of chemical engineering, and that was the one. You all have to take statics, and dynamics, and thermal, and because they assume that people that go to the Naval Postgraduate School have been out of school for a long time, not just the three years that I'd been out of school. Some had been out of school for as much as 10 years, so they have to always start people . . .

Misa: Even if they'd had statics somewhere, it was a long way back.

Raycraft: . . . yes, but at least they'd had it. You know I had never had statics, or dynamics, or thermal, or any of those courses before. So it was to me, I was scared. The rest of them were like, they'd go play ball, or whatever. It was easy for them. So that's probably why I did so well at school was because I had the fear factor in a way they did not.

Misa: What was the rough balance between men and women when you were taking this [course]?

Raycraft: Oh, man. I think there was maybe two or three women, to 30-40 men going through the program. It was very, very small percentages. I'm trying to remember, but there weren't many of us there at the time. There was Natalie, and myself, and maybe this other, Ann. It was small. The classes weren't that big anyways, which is good. But there weren't that many women at that time in the engineering duty officer. They really forced them to get the master's so it was always kind of in a man's world that you had to look to work with, but it never really was that terrible. Once they get to know you and realize that you were not really a threat and I would always try to help them, too. When you're at the Naval Postgraduate School, one thing I found is that other colleges maybe you were in competition, I don't know, there I felt like you were a team trying to succeed because you all were going to go off and do different jobs at the end. But we were in study groups, we all tried to work together to solve problems, that things that were really hard.

We had a really horrible teacher for thermodynamics. Maybe he was a good teacher, but he was from Israel and he had very broken English — we had a lot of foreign people at the Naval Postgraduate School — that people really had a hard time understanding what they were saying but needless to say they would come there. And he was very strict.

Misa: Sometimes even regular English can be a challenge, too.

Raycraft: Yes. But he had extremely hard problems that you couldn't really find examples for and we'd work together to try; and we'd throw token people at him to ask a question, and then they'd come back and then we'd try to continue to figure out what the problem was. But his style was that homework problems then would be done on the blackboard. When we would get done with; it was due that day, or whatever; and then he'd call randomly people up to the board. All of us would just sit there, and he'd go Miss Raycraft. [Laughter.] Oh no, my time is here. So you would go up there and you try to do it, and you just hope you got the one that the class figured out what the answer was, because that was what you were kind of graded on. But it was camaraderie at the Naval Postgraduate School and so you know, you had to kind of pull your weight there, too, you couldn't just be the slug who waited for the other guy to get the answer. You wanted to be the one that helped to solve the problem.

Misa: That actually sounds like a pretty decent learning environment.

Raycraft: It was a very good learning environment. Yes, I enjoyed my time there. It went by fast. I remember helping out even professors. I sent Christmas cards to professors. I still send one to one of my professors, and I never know if he's still alive because it's been since the 1980s. I mean, I left there in 1988 and I thought he was kind of old then.

Misa: So it was 1988 when you were completing your master's.

Raycraft: My master's, yes.

Misa: Did you return to your engineering officer duties?

Raycraft: I always was an engineering officer, that was my designator. And then they gave me back to another engineering duty officer job; and at that time, I wanted to go into a supervisor of shipbuilding, kind of like the same thing. The shipyard that was at first for the repair of ships, the supervisor of shipbuilding could do repair, but then also could do new construction and I kind of wanted to see what new construction was like. And lo and behold, they had a job opening in Sturgeon Bay, Wisconsin. Nobody really knows the Navy was even in Sturgeon Bay, Wisconsin, but they were building a new class of minesweepers. The program had not been going very well, very smoothly, there was a lot of technical difficulties in it because the challenge of doing everything without metal, for one thing, because you had to try and build everything with non-; it couldn't be magnetized, and then you didn't do wooden hulls. Wooden hulls in that area, those shipbuilders, Peterson Shipbuilders and Marinette Marine, [that was] their forte, that's

why they got the job. But installing all of this new technology at the time, because minesweepers hadn't built for like 20 plus years, and technology had taken such leaps and bounds at that point. So they were trying two different types of sonar, like a squeaky 32 was being put on there, and they had this — I can't remember the designator of this — type of remote mine hunting vehicle that they would put down and they'd have a tether and it was supposed to be kind of be your eyes underwater with a little snipper to take care of bottom mines. So as your mine is attached to the floor of the ocean, that it could swim down there and snip it, and it would pop to the surface and then they could shoot it and have it go off. They also had these big drums that had miles and miles of cable that they'd pull behind, beating different frequencies to simulate an aircraft carrier. The mines are very smart; they listen for a certain signature but they may not blow on the first one, they may not blow on the second one, they may not blow until the thirty-second one. It's a counter. So what you're trying to do is you sweep across this area so many times until you might have hit the count where all of a sudden, they would blow up. I always wondered about the mentality of people that are on these ships just because knowing that you are trying to set off mines, or dealing with mines, that that was your job, you know, is to try to find them, detonate them. Sometimes the detonation is by simulating a bigger type of ship that the mine wants to get, if you will. It was a fascinating area of counter intelligence, and mining, and everything else, but the ships that we built, they were built up there and tested up there through an acceptance test . . .

Misa: At Sturgeon Bay.

Raycraft: . . . at Sturgeon Bay, Wisconsin before they were accepted into the Navy and then they would go through the St. Lawrence Seaway, and then they would be out and deployed. Most of the minesweepers ended up being home ported in Ingleside, Texas, and that was kind of in the 1990s. Now, we just left the 1980s and went to the 1990s. And then some of them were — I think there's still a couple over in Japan and in the Middle East — that they had to heavy lift over there, because they didn't necessarily; they could get over there but you would really be wearing out your engines.

Misa: To have them go there themselves.

Raycraft: They were mostly deep water type of vessels. It was again, a challenging environment, but being built in the Midwest, you didn't feel as much of the animosity of women there. There still weren't very many women in the program, at all. There weren't very many military at that point.

Misa: Civilian shipbuilders, right?

Raycraft: It was civilian shipbuilders. They did have some women in some of their technical fields. I don't think I ever remember seeing any in the actual facility where they would be like gluing the wood together, and pressurizing it, and that; but there might have been some in the installation of electronics and things, but again, not many. In your procurement world, maybe, and in your contract world you would see them

Misa: You went there as a fairly high level supervisor, then.

Engel: Yes, I was only a lieutenant but I was like the military overseer of the contract onsite. The shipbuilder still is responsible for all of the details of building the ship. We were responsible for being [there for] the people in Washington, D.C., we were like their eyes on the deck plate, so to speak. We would still have to do our reports. We still would have to be in charge of budgets for making sure that the shipbuilders were being paid; progress payments, and that they were where they said they were. We would have our own team that would do progress [reports] and then they'd give me a feel for how far along they would be in their construction. We would have our own quality people doing their work, as well; and they'd have to prove to them that it's being better, of course, with the specifications. And we'd have, like I said, our own office of experts — it was small — that it would be when we'd actually go out on trials and such, we would be the team that would go there before the experts that would come for the final acceptance.

Misa: You began that in the late 1980s?

Raycraft: I went there in the late 1980s, back in like 1988 or 1989, and stayed there until the early 1990s. I left there in 1991. I actually had my son, I only have one child, but he was born when I was a supervisor of shipbuilding. I was eight months pregnant for one of our acceptance trials, and when the INSURV [Board of Inspection and Survey] came onboard, there's always a doctor, he did all the hygiene and things like that, but they gave him a hard time because oh, you might have to deliver this out here. [Laughter.] A clean

sweep on a minesweeper acceptance trial meant that you had very few deficiencies, nothing major, and the ship would be ready for delivery. So you'd always [have] two brooms at the end, you know, on your mast, if you had a clean sweep. But they gave them a hard time because they brought a little blue one and a pink one, just in case. But that was one of my harder trials because being eight months pregnant means you start your trial like 4:00 or 5:00 a.m. and you don't get back until almost that time the next day.

Misa: Physically grueling.

Raycraft: Physically grueling, and on a minesweeper, there's not enough room to hardly sit down and you're on your feet most of the day. By the end of the night I remember rolling into one of the racks going oh my God! [Laughs.] Made it through. But it was fun and it was an experience that I always tell my son, you were on acceptance trials.

Misa: That's right. Okay.

Raycraft: But you know they were a very mission oriented family. I mean, the Peterson Builders especially, was a very family-oriented ship builder; a lot of people that had their sons, daughters, whatever; I mean, it was a good paying job in a small town so you have that camaraderie. They build very quality type products, in serving notice that all the screws would line up just perfectly, you know. And just they had pride in their workmanship, in that Midwest type of thing. Marinette was too, but Marinette was really run by a bigger company. You still had the feeling that the workers cared about the

product that they delivered, but they didn't deliver as many minesweepers as Peterson's, as far as the way the contracts went in that day. But it was a great experience; still very junior, rank-wise, for the type of job. All of the jobs that I had, in the civilian world they would never give to people right out of college, let alone right out of college without really having had even an internship doing that kind of a job. The Navy would throw people into positions of responsibility very easily.

Misa: Well that first job seemed very significant.

Raycraft: Oh yes. It was. I should never have had that.

Misa: That's right; I didn't want to say that.

Raycraft: I should never have had that, never. I mean [pause]

Misa: But that's a fabulous learning experience. You get to learn more in a month than you learn in two years in some jobs, I suppose.

Raycraft: Exactly. And the shipyard also gave me an opportunity towards the end of my tour, to have so many months in COMAD systems area, so many in system planning, so many months in TAS, to give me a flavor for not just the ship superintendent role but other roles in a shipyard, in a managerial position. So it was a fabulous experience. The supervisor of shipbuilding role as well, being in charge of budgets, and work packages,

and we had more than one minesweeper going through at any one time. We might've had three or four in one shipyard, and maybe one or two in another shipyard.

Misa: And you'd be supervising both yards, then.

Raycraft: Yes, both yards, so we'd have to drive from Sturgeon Bay to Marinette, and back and forth. So it was busy, to say the least. But then after my supervisor of shipbuilding days, they put me at the Naval Academy as an instructor. So I got to do a role that my mom would consider a normal job.

Misa: Okay. [Laughs.]

Raycraft: She never could understand my other jobs, but she could understand teacher.

Misa: Teacher, okay. So this is back in Annapolis, then?

Raycraft: At Annapolis, yes. So there I got to teach thermal. [Laughs.] Yes, I had things turned around there. And naval architecture, they give you a lot of other duties as well. The Naval Academy I did find that they had 10 percent more women.

Misa: Ten percent students or faculty?

Raycraft: Students, and faculty, probably about that much, as well. The thing that I did notice with the midshipmen, in the roles — we're now talking probably, well, I went there in like 1991 or so — they were kind of intimidated going into the engineering, or even the technical fields because of the fact that they didn't have the ability to I guess to bond with other women, or to be accepted as well, to those groups that they needed to get through some majors. Or that they didn't think they were smart enough to do it. I found a number of them that were. You had to take weapons engineering, thermodynamics, naval architecture, in some form to graduate. I don't care what your major is, whether you're an English, or psychology major, or if you're an engineering major you would take more engineering classes, but they had a structure.

Misa: But all four of those fairly technical topics.

Raycraft: Oh yes. Just because you're an English major doesn't mean you can get by without doing technical subjects. So these women would take my class and realize they really liked engineering, and they never thought they were capable of doing engineering. At the time, I don't know if they were either brought down with it, or just thought that I need to get through the Naval Academy, I'll just do something that was thought to be easier as a major. It's really hard to find out [what] they were told. A lot of the upper classmen, no matter male or female, would tell the underclassmen you know, when you're in engineering that you have all this lab time. You have oodles of hours in the lab. It's super hard. And they make it sound so awful that it was hard to recruit midshipmen to come into that type of engineering, male or female, and of course probably fewer females

because they wanted to go sometimes to majors where they might have other females that they could study with, and that would be acceptable.

Misa: Janet, can I just comment, it's so interesting because this is the 1990s and this is when — not in all fields, but in computing — it's especially the case, but it seems that those arguments bore particularly on women. In the 1970s and 1980s, women had a different experience in computing and flooded in; but the 1990s, you're describing a situation, you put it in slightly different terms. Early on, you were describing that there was this camaraderie and you were problem-solving, and it didn't matter that you were one of a few number of women, but in the 1990s it seems like women for some reason were maybe having a bit more trouble.

Raycraft: In my earlier career, I knew I was always up against people that I had to prove that I could do things with. So it wasn't easier; I mean it took a while to get that camaraderie going, and I think it depended a lot on a person's personality. If you're willing to work with them and show; you had to prove yourself, and once you proved yourself maybe they'd come around to you. There might be some that you could never get by, like the one CO that I had, he always hated me, he never liked me. But in the 1990s, in the Naval Academy — women entered the Naval Academy in 1976, and had I gone I would've been the first class of women, but I didn't know about it. I was up in northern Minnesota; didn't have a clue that that was an option to me; and it was just an opening. From what I heard in the beginning, it was very rough for the first class of women midshipmen. And it got better, but it always was very hard, I think, for women at

the Naval Academy. Or for any of the service academies because you're still in the minority, you still had to prove yourself in many fields. It isn't just academics when you go into the naval service academy. They put you in a lot of positions. They treat the dorm like a ship. You stood watch, you had your battalions, you had your chain of command, all the time. You had your rules on what you could or couldn't do when you were off base. Only upperclassmen or seniors could have a car, whereas the underclassmen could not and never have. It wasn't an option. You always had to wear a uniform if you were out on the streets of Annapolis; but if you maybe went into a sponsor's home maybe you could have civilian clothes then.

Misa: Okay.

Raycraft: I mean, it was very structured. There were rules and timing, and when you had to make sure you were back in the dorms, and they watched you like a hawk. And then, you know, you had to do physical activities, too. If you weren't on a sports team, you still had intramurals. You still had to do other types of sports activities. You were a well-rounded person when you were at the Naval Academy. And then in the summers, you didn't have the summers off, depending on the year you were in, some years you stayed closer to campus and you did things on the yard patrol or you did things on the sailboats. You could in your senior year or your older years, you would go out in the fleet as a group of midshipmen assigned to ships, and submarines, and aircraft, and that. So they'd have midshipmen go all over the world and do certain things. But even then, depending

on where they sent the midshipmen, depended on where women could be at that time in the Navy.

Misa: That's right.

Raycraft: So like you couldn't send a woman onboard a nuclear submarine, or ships like that.

Misa: So the Navy was still trying to make accommodations and trying to find out how to [pause]

Raycraft: Integrate women into their program, yes. Some ships you could easily integrate them and others you couldn't. I mean, even when I was going out on sea trials, whether I was at the shipyard in the early 1980s, or even in the minesweepers, there were always worries about where I could actually sleep on the ship, or be on the ship because they weren't [pause]

Misa: Physically designed for that.

Raycraft: They weren't designed for that because sometimes you had to get to the bathrooms or the heads through a berthing compartment. And you know, a berthing compartment, you couldn't do that. And where could you berth somebody? So a lot of times I got stuck in medical . . . [Laughter]. . . where they had just one bunk there and

some access to a head at that point. So it was sometimes weird, but I never let it make me feel like I was inferior. I understood the situation, that was the way it was back then. In order to expand it you had to help them transition it and be part of the transition, rather than expecting it to go to something from nothing right away. The women at the Naval Academy are still, I think they're — the men that are going there now with them are a lot more open minded than the men that originally were there in the early 1970s and 1980s because they have mothers, sisters, whatever, women that are showing them the way. I know my own son has much more appreciation for what women can do because of his observation of what I can do. So their minds are open but there still is the fact that men, you know, like to sometimes use men, and women like to be with women, and sometimes there's mixed things. But even in today's culture, in some of the managerial positions, there are always golfing outings and things like that where maybe you don't feel quite as welcome, unless you force your way in. But that's just some. And sometimes more business is done on golf courses, so you just have to weigh it. It all depends on feelings of acceptance, but it is grooming. And the Naval Academy, like any place, there is always competition, you know, competition to be the number one student in the class; competition now to enter certain fields in the service. Actually, this was transitioning when I got there, but before, it was based only on class ranking. So if you were the number one person in the class you could go wherever you wanted in the Navy; you could be a pilot, you could go with submarines, you could do whatever. But they realized that that sometimes didn't work because a person that is number one in the class may not have what it takes to be a Navy SEAL, for instance, if they made things exactly what they think they want to be. So they started more of an interview process. Their class ranking

will help them in the interview, but you would have to apply to say that you wanted to be a Navy SEAL, for instance. And then they would have an interview board, and maybe not the number one person would get in, or maybe the 30th one who showed something in addition to academics.

Misa: Special aptitude or interest or . . .

Raycraft: Yes, exactly. Right.

Misa: So how long were you teaching at the Naval Academy?

Raycraft: I actually got a chance to do two tours.

Misa: Two tours. Okay.

Raycraft: Yes. I went there from 1991 to 1994, 1995 time frame. And then I came back in my very last tour before I got out of the Navy. I did 20 years in the Navy. I left in 2001, so like 1999, 2000, 2001, did my last tour there. And I did see a whole lot of change, you know, like I went and did a tour at the Naval Sea Systems Command in between, and then more as a technical advisor role for mine sweepers. [Laughs.] So I went back to my minesweeping roots, for a while.

Misa: And where was that located?

Raycraft: At Crystal City, in Washington, D.C., I actually I stayed in Annapolis because I taught there, but I commuted to Crystal City for three years. Then I said, you know what? This is enough, I'll just do my last tour here before I get out. And then came to Lockheed and then they brought me right into the Q-70 program as a program manager. So it was an interesting time at the Naval Academy, because you did see a lot more of people, of midshipmen trying to find what their role was going to be into the Navy. And some adapted very well, while some usually if they were going to drop out, they dropped out in the first few months. And then they pretty much stuck it out after the first year; when they started their second year, then they started making a commitment where they'd have to pay back if they decided to drop out. But there were a lot of amazing students that went to the Naval Academy and obviously they're hand selected, they go through a lot of grueling interviews and I think they have like 12,000 applicants and they have to allow only 1,000 a year.

Misa: So it's a pretty stiff competition.

Raycraft: It's a stiff, stiff cut.

Misa: Can you describe a little bit your work on the Q-70?

Raycraft: Sure. That was a program that was the introduction of COTS equipment. It was probably the biggest COTS integration into the naval forces.

Misa: That's Commercial Off the Shelf.

Raycraft: Commercial Off the Shelf type of program. So they wanted to take things that you could get, computers, and put them in a shipboard environment. A shipboard environment is very grueling because you have a lot of vibration, just typically you have a lot of vibration, humidity, temperature swings, you have electromagnetic interference, EMI, which could affect the operation of the equipment unless it's shielded properly. But more importantly, the big test that you have to do is shock. You have to assume that the ship could be in a warfare situation where it could take a direct hit and then can operate, the equipment can continue to operate through that type of environment.

Misa: You're talking about physical shock, not electrical shock.

Raycraft: Physical shock, right. So they take the equipment — and our claim to fame is that we could take this Commercial Off The Shelf stuff — and put it in Iraq and isolate it with shock isolators, that it could withstand all of these types of conditions. We'd have to take the whole entire equipment and put it through a series of tests called EQT, Environment Qualification Testing, and we would run it through its paces. The last test is you'd stick it on a barge out in West Virginia and you put a charge in the water and blow it up. [Laughs.] You wouldn't go right under it, but the tests would start at so many feet away from the ship, and then you'd do the first one to see if it worked; go a little closer, see if it worked; a little bit closer; they'd do a series of four shots until the final one is

fairly close. It's not on the ship, obviously, because they still wanted to keep their barge. And then you'd record to see if it continued to operate through the shock or not; or if it stopped and reset and then started up again. Usually, that was acceptable, that would be for a Grade A classification. Grade B would be as long as it didn't kill anybody, you know, it could not work afterwards, but did anything fly off of it. If it cracked, like if a display just shattered but nothing flew off, then it's good enough for Grade B classification.

Misa: It would be hazardous if a Navy officer or . . .

Raycraft: Enlisted person was in front of it . . .

Misa: . . . was there, they would get showered with glass.

Raycraft: Right. So those are the types of tests that would make a computer safe to be operated onboard ship. And then that type of computing environment would be combined with the software that would go and operate sometimes weapons systems, which would be considered mission critical, or it could be a communications system, which maybe it wouldn't be mission critical but mission essential. We would take, depending on the requirements, the people in Eagan at Lockheed Martin would design it so that it would fulfill the requirements and still be Commercial Off The Shelf. The goal was to be able to reduce the cost and keep up with technology, that was what we were trying to shoot for. The submarine community did it a little bit better than the surface community only in the

sense that they had a program that realized that COTS would go obsolete every 18 months to two years, so they would always have a program to upgrade it before it became obsolete. It was a routine, a good business rhythm if you will, so that they never were caught with a situation where they couldn't find parts. Whereas the surface community didn't have necessarily the money that the submarine community did, so they were sometimes thinking that they could make this COTS equipment last many, many more years — like 10 years or more — when COTS doesn't tend to do that easily. A simple chip might; they just don't make it anymore; you can't make any more. So either the community would have to do a lifetime buy, or transition to something for them that functioned, which would be the best case. Or totally different and then you go back to qualification testing again. Not only the qualification testing that I described, but if it was in a weapons system they would have to go through a much more stringent qualification to make sure that the missile or whatever that it was shooting would not go off target, based on the new change to the equipment.

Misa: Could you describe your work, your personal work?

Raycraft: My personal work as a program manager there, I was the direct interface with the customer. The Naval Sea Systems Command, they would be in charge of — well, the Q-70 is kind of strange because there was always this group that was in charge of the contract that would come to Lockheed Martin to make sure that we met their requirements. But then there was the user community that would deal with the contract community and those two Navy entities we dealt with. That was my role, to deal with

both of them, to make sure that the contract was complied with, as well as understanding

what the user's concerns are with not only the operation of the equipment but with the

maintenance of the equipment, the long term lifecycle support. If the fleet was having any

issues, they would be the first ones to know and then we would work with the contract

person to figure out a way to fix it.

Misa: Who would represent the user, then?

Raycraft: The user would be — there's a program office in the Naval Sea Systems

Command as well that would be in charge of like the AEGIS community, and they would

have their code and then they would deal with IW-6, which they were the contracts

organization, and then they both would talk with us. Theoretically, we were only

supposed to take direction from the contract, but we would always have a meeting. There

would be a number of managers from the Q-70 world because there are so many different

programs that were mandated to use the Commercial Off The Shelf type of equipment,

the Q-70 equipment. So even though there are communities with contracts that I would

be responsible for — like vertical launch, etsi ketsi, I had all those — I always call

myself the cats and dogs. I didn't have the big guys like the AEGIS community, or the

team sub. I ended up eventually getting the SPAWAR community, the Space and Naval

Warfare, that would do more of the communications, after one of my — now he's here as

well — but when he left Lockheed Martin his program transitioned to me. But we were

all under the Q-70 and [SPAWAR], so our programs might've been for different users

but we did try to keep as much commonality amongst the Navy so that they could get the

best bang for their buck when they would go and buy stuff; try to keep the cost down; try to keep the sailors so that if they went to one Q-70 on one platform and then happened to go to a different community themselves, would understand this is very similar because it would be the same type of equipment; maybe it's a different application, depending on what it was firing or running at the time.

Misa: So the Q-70 is a family, then, not a single model.

Raycraft: It's a family of products, not a single model. Even with one, like the AEGIS community could have various types of cultures that, depending on functionality, in the SPAWAR community that I dealt with, they would have like a data center rack, a switching rack, there's a backbone switch, an edge switch, and a data center, and they would have different components in that box that would be interconnected in the network that would run all of their programs. So they would have an architecture of their own, and typically — I'm trying to think — some of the cases we would help design that box to fit in there; we would go through the whole design process. We would have a systems requirement review, so if you were given a project early on, for instance, you would work with the user community and the contracts community, and they would give you a set of objectives, you know, of requirements. And then you would have a preliminary design review or you would go through with their technical community and our engineers, say okay, you wanted a system to do this, this, and this. This is our preliminary design, this is your requirement, we put together a requirements verification matrix. You said this requirement, this is how we're going to go about meeting that requirement, and this is

how we will test for this requirement. So we would continue to grow as you would get your design finalized. And after the preliminary design review, when everybody's kind of in agreement, then you'd start going to a critical design review. Now the design starts becoming to look a lot more formalized and you would go through and explain exactly how you're going to do that requirement. On paper, they all look beautiful; it's going to work. And then you build your prototype, your Engineering Development Model, your EDM, and through the EDM, that was the unit you'd start running those tests I was telling you about, the EQT tests, to say okay does it functionally do what you want it to do? And will it continue to functionally do what you want it to do in a stressed environment? Can it pass all these tests? Once you get through all that, then you go through what's called 'transition to production,' where all the changes you might — it never comes out perfectly the first time through — there's always going to be little tweaks to the design and then things that you're going to have to do. Once you're done with all the testing, then you go through transition to production. Is it producible? You may still have to do a couple tweaks in that phase as well. And that's where we would work with the DRS Corporation in Johnstown, Pennsylvania. They were the builders of most of the Q-70 product line.

Misa: DRS?

Raycraft: DRS. It doesn't stand for anything, but they're now Finmeccanica, they still are DRS out of Johnstown, Pennsylvania, or New Gaithersburg, and they have a number of field offices. And Lockheed Martin had a facility down in Clearwater, Florida, where

they build Q-70s as well. So as a program manager, you had to deal with all the phases of design, and then transition to production and deal with the yard, or the factory that was going to be building your new product, whether it be Johnstown or Clearwater. When I was dealing with surface work in Johnstown, Pennsylvania, but when I transitioned into this [Bay World build line], they were specifically built out of Clearwater, Florida. Those are the units that you would build, and they would be the ones that actually would go to the fleet and get installed by shipyards. Typically though, Lockheed Martin would never — in my role — we never had installers that would do that. We may have field engineers that would be based out of Virginia Beach, and sometimes in Eagan, that would go out to the ship to troubleshoot systems that were out there. And as they were troubleshooting your box, if you will, then you would get involved in that portion as well. You still would deal with the program office out of Crystal City, in Washington, to correct it.

Misa: Were there different types of field engineers? Sometimes, for some companies, they had customer engineers, and field engineers, and there's a bunch of different people that are basically somebody that goes to the customer and does a hands-on problem solving.

Raycraft: There are hands-on problem solving people. They would be usually assigned to that job. We would have to get feedback from the fleet to say the Q-70 isn't working on the whatever haul. We would send somebody that's from Eagan or maybe Virginia Beach, depending on the location and what the problem is because you just never know what you're dealing with. If it's a brand new design, the guy who built the prototype and

helped transition it to production is probably the guy that I would send out there first. If it had been in the fleet many, many years and we start using the Virginia Beach facility a lot, and those guys got proficient in that type of a console, then I would send those guys out there. But they would be unique in the hardware primarily of the Q-70. The software not so much, unless it was the diagnostic software that was embedded in the Q-70 because the Navy would always take off whatever type of software we would install and put in their special — whether it would be weapons system software, and usually the people in Eagan or Virginia Beach did not know [it]. It could be secret software [pause]

Misa: The specific application.

Raycraft: The specific application software was a little bit outside of our realm. When we built the SPAWARs [Space and Naval Warfare Systems Command], we would do the free and open software to just test it, and then when we delivered, they wiped those things clean. [Laughs.]

Misa: Installed something else.

Raycraft: We don't know what the heck they installed. So we typically weren't called out for a lot of software issues, but unless like I said, if it was something that we were a little bit uncertain if it was a diagnostic software, we might have somebody that would either do work remotely or that had a little bit more expertise that could go out there. But most of our field engineers were our troubleshooters for the hardware situations: crimped

wires, loose grounds, connections not being hooked up correctly, just servers that didn't operate. I mean, a lot of times there might be something that didn't show up until you actually put the application software on there. That what you thought you were simulating when you were doing all your factory acceptance testing, and you get through testing, it wasn't quite what they were going to be putting on it and doing, and you'd have to; maybe it was hardware, maybe it was software, you know you have to work with them.

Misa: You ended up getting exposed to how computers were designed and built, and then put into field operation. This sounds a lot like the minesweepers except that instead of minesweepers it's doing computing.

Raycraft: Exactly.

Misa: How did you find learning about computers as a product? I mean, there are the people that are the technical experts but you still have to be able to [pause]

Raycraft: Speak some of the lingo and . . .

Misa: Exactly.

Raycraft: . . . and go out there. Well it was interesting because from what you've understood from my background, mostly, it was hard work, shipbuilding, things like that,

and then during the Q-70 program, all of a sudden I was more in the computing world and that really wasn't my background. Yes, we had to use computers in my job, you know like at Sturgeon Bay, that was the first place I remember computers on everybody's desktop. Before that, nobody had a computer to work with — laptop or desktop computer.

Misa: Right, computers were in some big room somewhere else.

Raycraft: Some big room and you had to put these punch cards through.

Misa: Right, back to your FORTRAN days.

Raycraft: Back to my FORTRAN days, exactly. It was in Sturgeon Bay and the only reason I remember this specifically is because you always had to type logon blahblahblahblah or something like that to put your word in. Well, I named my son Logan, and one day I called him and [said], 'hi, logon.' [Laughs.] So that's how I know exactly where I first started doing computers on my desktop. So then, of course, it was Word-type documents and that. But now I'm in an industry where the computers are doing applications, and there's hard drives, and there's processors, and there's displays, and there's keyboards, and all this. It really is like on the job training and listening, you know, listening to the applications, listening to try to figure out what was the cost/product we're dealing with, who was the vendor, and because we were dealing with Commercial

Off The Shelf, we at Eagan, didn't really have a lot to say about the design of the

computer or the hard drive. We had to use what a company had designed.

Misa: So you're doing this repackaging, in a way.

Raycraft: It's exactly the words that we use is we repackage things. And our engineers

would sometimes have to work with their engineers to say, you know that shock test?

You need to provide a little clip to hold this down more, inside the Commercial Off The

Shelf. Is it really Commercial Off The Shelf? Sometimes. It's more of what we call

MOTS than COTS, which is Military Off the Shelf. I mean, would they ever sell it to

anybody other than the military? Probably not. I mean, the Commercial Off The Shelf

vendors we dealt with, in their small niche communities, the Victor Mains of the world,

or Themos, or Barco, they worked for the product that we were selling. They worked

with the product we were selling. They would work with the Q-70 program to give them

— because we had large volume and that was enough for them to work with. The Dells of

the world, we went to them wanting to use their product and when they found out how

few we needed in relationship to their other market, and how we wanted to stabilize it,

and wanted to keep it for x number of years; they looked at us like don't bother me. It

wasn't worth their effort. So we had to find ways. Sometimes I had to deal with the

vendor, as well as the user. You're kind of dealing with everybody, so you have to learn

to talk with vendors to tell them what we need to change their product to; to users on

what is it that they need to do this, what they could maybe work with. Sometimes they're

asking for a miracle that you can't deliver. Nobody could deliver, unless you wanted to

go back to the early 1980s days, when the people in Eagan built the UYK-7s, the UYK-43s, and they were very, very specialized. There's a lot to be said for that because some of those are still in the field today, you know, for many, many years. So it was an interesting job because you never knew what you were going to do from day to day. You didn't know if you're going to be dealing with your own team, or dealing with a vendor, dealing with a user, dealing with a technical issue that you're trying to overcome, or if you're trying to maybe sell the user on another type of application that maybe another community was starting to use that might be beneficial to them as well.

Misa: How large was your team, people that you would be responsible for?

Raycraft: A program manager never had anybody directly; in Lockheed Martin the way the functional organization worked was [pause]

Misa: So you're coordinating with everybody, okay. [Laughs.]

Raycraft: You coordinate. You coordinated with quality, you coordinated with contracts, finance, the engineers themselves, and such. You would have certain people assigned to you, like I would always have a lead project engineer, and they would have two or three people who would work directly for them for the product line. But then they might have a mechanical engineer just doing odd jobs for them, or electrical, but the integration, they would be the system integrator that would work with the project engineer. So you'd have all these layers. You would consider mostly the system integrator, the project engineer,

and yourself as being like the core team, and the other people that you pulled from occasionally, you may have a quality person assigned to you, you definitely would have a finance person and a contracts person. Contracts kind of fell across the whole Q-70 area, and quality, they had one quality guy maybe specializing in three or four other projects. And you'd have the ILS person, Integrated Logistics Support person that would help you with your product line. I'm trying to think of other organizations that you would have — testing, you know you'd have a group of testers that would try to test all the Q-70; again, trying to keep your specialization but then there would be a few that would specialize in surface consoles, a few in submarine consoles, a few in like the Space and Naval Warfare consoles. So they tried as much as they could to work with such a big program, with as few people as possible so not everybody had duplication, and that meant commonality, so that if they saw a problem on one console and you were building another one, they could warn you [that] 'I saw this over here, you might want to change this here.' By having the same vendor but working with slightly different application, like Barco — Barco was our display vendor — and they made multiple displays across the Q-70 product line, product family as we called it, because they knew how to ruggedize the glass. And maybe this one needed a little different size compared to another one, or different functionality, but by being a preferred supplier, if you will, working with them they tried to give you better price breaks. They tried to work with you to give you the functionality that you needed. They knew the requirements for the environmental testing so they could design that in from almost day one to work with the group. And then we'd have a product assurance team that would try to work with the Q-70 family and keep track of all of the transitions, things like end of life, what is the next thing available? What's the newest thing out on

the market that we might have to start integrating into the Naval product? And again, working with our customer, did you know this is going obsolete? Here is a good replacement for that and try to sell them on it before it became catastrophic, because if all of a sudden you're in the middle of a build and something goes obsolete, you're stuck, your factory's stuck, and you can't deliver product.

Misa: Jan, I have kind of a slightly broader, reflective question, you've worked in a number of very interesting places for a woman to be working, over your career, from the ensign days in the shipyards, and the minesweepers, . . . [Laughter.]

Raycraft: All sorts of crazy places.

Misa: . . . and even in Annapolis, in some ways. How would you characterize the working environment for a technically oriented woman at Lockheed Martin?

Raycraft: You know, I had some great female technical workers as well. And the ones that I think about, going back, they were in the software area. There was a peripheral emulation program, PEP as we called it, software program that I was the program manager for — like I said, I got the cats and dogs. Stan Warren was my project engineer, but we had a number of women that were the coders, the system administrators of this program, that they were, you know, they could do so much. They were very, very intelligent, very organized, knew the ins and outs of that program very well. But I think about how many in Eagan there were, it doesn't strike me as being, again, lots of women

in that field. Because of the software, we had Sue and — oh, I can see her face — and then Amy came in, she was a younger one that came in later on. But in proportion, again, it was a small number of women. I'm trying to think even in the prototype shop, we had a few women that would go out. You'd have to get their story, but it seemed like they were always having to prove themselves, as well, out in the field. But they handled themselves beautifully.

Misa: You mentioned going out with a cleaning rag or something — kind of proving yourself a little bit.

Raycraft: [Laughing.] Right.

Misa: So if you're in a field engineering situation, you're going somewhere else, you're not just working within a group that you may have a relationship with. You have to be forming those relationships . . .

Raycraft: All the time. And show that you know what this Q-70 is all about. It seems kind of strange but even into the 1990s when I came there — well actually I came there in 2001 — until the shutdown in 2012, is my experience at Lockheed Martin.

Misa: The Eagan plant?

Raycraft: The Eagan plant, and I was just only at the Eagan plant, that they still, you know, there weren't that many in the field of engineers. Again, they had to show it and prove themselves when they went out into the field. Once people knew them, then they could do whatever they wanted because they had got their reputation. But it was always a challenge. And I don't know if it was the challenging, always trying to prove yourself, that was maybe some of the reason why people didn't want to continue doing that. Or if it was just other places were maybe starting to open up even more so that it just spread out more, you know, that computer science, you know from the days of Grace Hopper, you know Admiral Hopper, who was [pause]

Misa: We study Grace Hopper very closely.

Raycraft: Very closely. I mean, when you think of her and her attitude of just do it and ask permission later type of ways of getting into it. You could do a lot of programming without — I mean you never knew really who a programmer was. You know you could be in a little black box and submit all this code and nobody really judged you but just judged your code. Maybe it was an easier field at that time for women to prove themselves; you didn't have to go through your face because people could just look at your work. It's almost like being a novelist, where you put a secret pen code, and you give it in there, but everybody looks at it and it works beautifully. Maybe after the fact you realize a woman did it, but by that time it's too late, it's already working, it's too late. Whereas later on, in other fields, it was always fighting, you know, like proving yourself first before they could really look at your mind. It took a while to break those barriers and

now that the barriers are being broken, then it's easier for women to go into other fields. Engineering is one. And maybe they all have to huddle in one, like computer science. I don't know, I'm just trying to think of other reasons why that field — and I'm not sure if you're looking at all technical fields — you know . . .

Misa: The Sloan Project is particularly focused on computing because the figures were so low in the 1960s, and to be perfectly honest, are so low now. The other engineering fields started out pretty low in the 1960s — 10 percent or something like that — and have grown slowly, but they've never had either the rapid increase in the proportion of women from the 1960s to the 1980s, nor the rapid fall in the proportion of women. And the 1980s really until the present has really been a decline and it doesn't make a lot of sense. Part of it is other options, that women maybe are going into different fields but then that doesn't really explain why computing for so many years — 20 or 25 years — was so welcoming to women. So we're continuing to try to understand that.

Raycraft: It is really a kind of a strange environment. My son, although a psychology major, now is going back to get a professional IT degree. He loves computers, but he also loves gaming and things like that too. So computers and using all that stuff as a young child, you know, boys like that. Girls nowadays, I see that they like some of that but they take it in moderation, as far as my great nieces that I see — and maybe it's just that the boys, now men, continue to really want to get into the computer industry because they always associate it with the gaming and stuff like that. Whereas women are looking at more business and maybe just other applications of their math and science, and

computers are I don't know, maybe it's just hard; everybody wants to do it; you know, it's kind of like everybody wants to be the next Apple, do their own apps and things like that. I don't know, maybe there's other things or maybe it's [a] sense of capability.

Misa: It used to be the case people thought that gamers were all men but I don't think that's the case anymore. The latest statistics are that it's half [and] half. And yet if you look at the gaming industry, who's creating games, it's a sector where there are very few women. Maybe it's high pressure work, or long hours; you know when you've got a game that you're trying to ship it's very time sensitive. So the sky's the limit in terms of work so the concept of work/life balance — no balance and no life, just work. [Laughs.]

Raycraft: Just work, yes.

Misa: So that's difficult for some women and probably difficult for many men, too, that's the thing. So this is not like it's only women, but it's also most men aren't computer-game designers, as well, right?

Raycraft: Right.

Misa: So there's a lot of different things to sort out, and at least with the contemporary situation. It's still, for me, an enduring puzzle — why computing is so central to our culture and yet there still seems to be these prominent disparities that today seems more like the 1960s than like the mid-1980s. You've lived some part of that and to get your

perspective, for sure, from the military point of view, but you were working in very challenging places for a women to be working, and seemingly had a very satisfying career. So that's an interesting example.

Raycraft: Oh, I did enjoy it. I mean, it was hard and sometimes you know you think why don't you just say the heck with this and just go do something totally different. But you know I always take each day at a time and enjoy the people that I'm working with, and continue to move on, and don't look at the negative, try to look at the positive in every situation. It's all a learning situation. And like I said, the Q-70 line, I didn't know a thing about it. The guy who hired me, he recognized the fact that I may not have had the computer science background or anything else, but he said you would fit, and that was what he was looking for was a personality that would fit with the people that were in the positions already, whether it be at the Eagan plant or with the customer, because I had the military background to give me credibility with the customer.

Misa: Exactly.

Raycraft: And yet I had the personality that I wasn't a military officer that would bark orders. I never was that type of military officer because I never really had any enlisted people working with me. I had civilians I worked with most of the time, and it wasn't in my nature to be that type of a manager, anyways. I always wanted to promote a team environment more than anything else and that's what Q-70 was. Q-70 was a family within Lockheed, and the people that worked in the Q-70 program worked as a family

[and] we all tried to help one another. The people who were there really grew up together. Those women you describe during the early computing days, you know, grew up in that area. All the people that were associated, the men and the women got [along] together really well, they played softball together, they did bowling, and their families grew up together. It was that kind of environment that I ended up being lucky enough to join when I joined Lockheed Martin. They kind of took me in the fold and helped teach me some of these things with the computer. Am I a computer expert? [Laughs.] No, no, I still am not, but I know what some of the issues have been in the past with other computers because I listened to the problems. I don't know exactly what the problem is but I can ask some questions to make somebody think and then go oh, well yes maybe. I might've brought up something old that I remember hearing. And sometimes the obvious thing, you're looking so closely at it you don't look at the big picture. Obvious. And that might be something they think about — oh, yes — and then they go back and try a different route of looking at it. That's kind of what I think a program manager is, is somebody that might not be an expert in any one of those many areas, but can draw things out of people.

Misa: Kind of integrate across several different areas of expertise.

Raycraft: Right. Or get two people together that, you know, this person knows a little bit about this, and this person is; why don't you two talk, and sometimes a solution can come out of that. You just kind of keep the balls juggling all at the same time, and keeping the lines of communication open, that's the biggest thing I think in program managing, and probably in any industry.

Misa: Speaking about asking the right questions, I'd appreciate it, Jan, if you'd suggest some further lines of questions that I might not have had the chance to ask you, that I might ask in subsequent interviews.

Raycraft: You know that could be something, too, I was lucky. Well, I'm in a different situation than probably some of the other people you're going to interview because being in the military for 20 years, from day one I was a manager, which is who really gets to be a manager right out of college? Granted, I always had a chain of command I had to report to, but I was always given a position of authority, whereas I would be curious; again, how were some of the women treated compared to their male counterparts, working in the same position.

Misa: Good question.

Raycraft: It might be in the computer science industry maybe they didn't really have a lot of distinction because the code was the code. I mean, it's a profession that, to me — and maybe I'm looking at it wrong — but it's between you, and the screen, and the output. You don't have to maybe deal as much with other people. You're obviously getting the requirements that you're trying to code, and then when you are at a situation, you can talk to your coworker on a fact basis, you know, like if/then, blahblahblah, or whatever the coding part of the thing is. And you can start talking on that aspect and you're not talking on other things that maybe a male might think that a female doesn't

know too much about in other type of a technical world. Like in my job, they would always question like do I know how an engine may operate, or how finance might go, or what the quality aspects of it [are], or things like that. But if you're talking, trying to figure out a solution, I would think it would be an environment that was more stimulating, you know, with men and women that they could — oh no, no, try this, or go through this type of coding, and there was no real right or wrong way of doing it as long as you could get to the bottom line of your solution. It's like when I was at the Naval Postgraduate School and trying to do those homework problems that I was just describing to you, that we *all* were maybe not too sure how to do it so everybody's suggestion was welcomed at the time. So it would be interesting to find out if in that industry at that time, since computers were new to everybody, nobody was an expert yet at that, so everybody was learning at the same time and men couldn't automatically assume that a woman didn't know it because they didn't really know it either.

Misa: Maybe that was. I could imagine at least the birth of this more cooperative learning is quite attractive.

Raycraft: Right. That they wanted to experience. And if I had known more about it, I probably would've found the same thing, that you didn't have to prove yourself because nobody was proven themselves. We were working together and it probably made it seem more attractive to the women going into that field. I also know that Lockheed was very good to a lot of the women that were going through there that were going to have children. You know, that sometimes they had to take time off, or work part time, or job

share — we did a lot of job sharing — and in that type of environment, that you could step away and step in easier probably than some of the other communities at the time.

Misa: Lockheed, even way before you joined, was known as being respected for having family friendly policies.

Raycraft: Oh, definitely.

Misa: That went back, I think, to the 1970s and for sure by the 1980s, because Lockheed and IBM were the poster children for being welcoming and respectful, and a good place for both men and women — but especially women who were having kids — to work.

Raycraft: And that was really important, I think, back then to know that you had a job that you could take some time off and come back to and still be able to have your job, and know how to code, and you don't lose that. I'm trying to think of why people would; other than maybe it just being more opportunities now, because barriers have been broken in other communities, like when I went in, they were pretty bad, and nobody wanted you there to begin with. They just didn't want you so you had to fight to get in. Being in the military I didn't have to fight so much because they just assigned me. [Laughter.]

Misa: That's right, that's it.

Raycraft: Here's your job, and now you have to stay there for three years, like it or not. I guess if things had really gone bad they could've moved me but, luckily, I was able to make it work for me. But I don't know; it's a very challenging research project that you have right now.

Misa: And it continues to go on. Jan, thank you so much for your time this afternoon.