Interviewee: Raymond Larsen | By: David Zierler
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ZIERLER: This is David Zierler, oral historian for the American Institute of Physics. It is May 4, 2020. It's my great pleasure to be here with Ray Larsen of SLAC. Ray, thank you so much for being with me today.

LARSEN: My pleasure.

ZIERLER: To give some context, this is interview is part of a broader oral history project on the rich and wonderful legacy of SLAC. And so Ray, to start, can you please tell me your title and your institutional affiliation.

LARSEN: My title is officially "retired," but I'm still on part-time staff at Stanford — at SLAC, rather. But my title was — I had a lot of titles, but the most significant one was head of the electronics department, which at that time included — it's really the size of a division today. It was like, over two hundred people. It included my specialty areas, which were controls instrumentation, and to some extent microwave front-end interfaces to electronics. So, there was a controls group, a physics instrumentation group, a power electronics group and lots of standard instrument module business. And we had an electronics shop that was very sophisticated compared with other labs. We could build multilayered circuit boards and designed very complex hybrid integrated circuits that we needed for detectors that were, at that time, just very new to the industry. So, we had the good fortune of being close to Silicon Valley, so there were a lot of suppliers that were cutting-edge, and we took great advantage of that.

ZIERLER: Great. Let's take it right back to the beginning. Tell me about your birthplace and your family background and your early childhood.

LARSEN: I was born in Viking, Alberta, Canada. Viking is, as you may gather from the name, was a predominantly Scandinavian town. At the time, it was populated with a lot of immigrant Norwegians and Swedes, and it was at a time when it was a huge migration. I was born in '34, but my dad, with his entire family — he was a 15-year-old kid at the time, --but he and his entire family emigrated in 1922 from Oslo. They lived up north of the Arctic Circle near a place called Fauske. But to get a ship out, they went down to Oslo, came to Canada via a stop in Southampton to change boats. But they arrived in — I don't know the exact date -- but it was in April of 1922. And my dad's family consisted of the mother and dad and 11 kids, the largest family, I think, at that time, to ever immigrate as a group. And it was not just them, but there were two other f large families that were relatives — not named Larsen, but they were relatives. And between these three families, there were like 35 people immigrating all at the same time. So, that was the beginning of my dad's family adventure, and they landed in northern Alberta in the farmland. They thought they were going to [laughs] the place where the streets were paved with gold, and they ended up in about the most inhospitable part of the country you can imagine, especially in the wintertime.

ZIERLER: Any idea why Canada and not the United States?

LARSEN: I think the usual reasons — that there were some predecessors who landed there, and they had connections. So, that was really the — I mean, that's how most of immigration happened. My wife — I should say my first wife, because she passed away — but her parents were both from Norway, and they had a ton of relatives, and they were all in the U.S. They were in the Dakotas and Montana, and you name it, in that area. Minnesota. And there were a lot of them. And that whole area, as you know — Minnesota is still considered to be a very Scandinavian state.

ZIERLER: Right.

LARSEN: Anyway, I was born in 1934, and my mother told me it was on Easter Sunday. I know it was a Sunday. It turns out it was not Easter Sunday, but she always maintained that it was. But we didn't stay there long, because this was the midst of the Depression. And what the Depression meant was that you were scrambling for a living. My dad, when he first arrived there, had a 10th-grade education in Norway, which actually at that time was considered to be pretty good. And they had learned English in school as well, so they assimilated quite well, but the boys — they had a bunch of boys, and the older ones just went immediately to work.

ZIERLER: Now, your first language was English? You spoke to your parents in English?

LARSEN: Yeah, my only language at that time was English. My parents used the native tongue so that we wouldn't know what they were talking about.

ZIERLER: [laughs] Right.

LARSEN: But they did not want their kids to — they thought by teaching us Norwegian as the first language — which is kind of hokey, but that's what they thought -- they thought that would be a disadvantage in starting school, because the school obviously was going to be only English, and not multilingual. And later on, I discovered when I was in grade school, we were in a whole different ethnic neighborhood, and there were a lot of Russian kids — immigrants also — who had landed in that area, and most of them came to school, to my first school in British Columbia. Many came to that school not speaking a word of English. And the dad spoke English because he had to, because he worked, but typically the mother and the kids did not. So, it was sort of tough sledding for some of them. Anyway, I spent only two years in Alberta before my dad — this was really, really tough times. I mean, they had to scrabble. At this time, they owned a pretty good chunk of land to farm, but the winters were very long and bitter. Being in a depression, they got peanuts for the produce that they would go and try to sell in town. I mean, everything was really tough sledding. So meanwhile, an uncle had gone west to British Columbia, and he ended up in a mine — a gold mine — in B.C., and he sort of told his brothers, "Hey, this is the place to come, because I'm making 5 bucks a day." You know? You're lucky on the prairies to make 5 bucks in a week or two. Anyway, when I was just 2, they packed it up and moved to the west.

ZIERLER: Where are you in the birth order?

LARSEN: I was the second. I had a sister, two years older. And then I had a smaller sister. When we moved, there were three kids. And my second sister is just a year and a half younger. She's still alive and well, but the oldest one has passed away.

ZIERLER: What job did your father take in British Columbia?

LARSEN: He and three brothers were all on a shift of hard-rock miners that did all the dirty work in the mine. This was quite technical work. They loved the work. They thought it was wonderful. It was technical. There was some science to it. Not to mention good pay, but they enjoyed the job of drilling and blasting, and it had its dangers — lots of horror stories about that — but they did love the work. The only problem with it was nobody in the mine hierarchy bothered to mention that it was kind of a death trap, because people — it was before wet drilling. It was just dry drilling with a diamond drill, and dust flew everywhere, and they breathed it. There was no protection. So, half or more of them got silicosis. My dad and three brothers ended up working that mine, and every one of them got silicosis. What it did was it didn't kill them outright, but it was kind of a slow death, and it compromised the health of all four of them for the rest of their lives. And the oldest one, who was the one that found this job, and he was a shift boss, he died about four or five years just after they had quit the mine and moved downtown. And we moved down — I was only up on the mountain — we were in the mining camp for two years, from my age of 2 to 4, and we moved down to the nearest town that had a school, because my elder sister had to go to school. So, they all moved down, and all of the brothers at that time ended up in this same little town. And it was a great little town. It was very small, but it did have a nice school and good teachers. But in the meantime, my uncle —the oldest uncle who had kind of led the pack —died a pretty horrible death of silicosis.

ZIERLER: How did your father fare?

LARSEN: He lost most of one lung, and to complicate things, when he had — oh, and the treatments for silicosis were all experimental. They didn't really know what they were doing. One of the treatments was to breathe aluminum dust, hoping it would somehow attenuate the spread of the disease. I don't think that was ever proven to do anything useful. To complicate things, he also — when I was about 12 — got tuberculosis, on top of his silicosis. And the treatment for that was: he could go to a sanitarium, or he could stay home in isolation. So, he stayed home. But he was flat on his back in bed for a year. That was the treatment. Isolation and whatever. There was no real treatment that I know of. There was no vaccine. But he amazingly recovered. Only many years later — I don't know, a couple dozen years later, he got tuberculosis again. It was just after I moved down to SLAC. I got a phone call that he had been diagnosed again. He had to go back into the hospital, and this time he went into the hospital for another year. Aside from that, he was a businessman. He sold life and general insurance, he built a hardware store with a son-in-law; he ran the local Farmer's Institute. He had all kinds of small businesses. He was also kind of a paralegal guy in this small community. He just knew a lot about different — how to get different things done, so a lot of the people came to him for advice. And late in his life, he ended up getting an appointment as the Magistrate —a Judge position — for the Province of British Columbia, in this town. So, for a kid with a bit of an accent and — [laughs] which he carried — he couldn't really get rid of — and a 10th grade formal education, I think he did some remarkable things.

ZIERLER: Did he survive that second bout of tuberculosis?

LARSEN: He did. It was a miracle. They were going to do surgery on him as a last resort but the TB had spread so badly that they called off the surgery. But then he started improving after a few months and got totally well! But it all took its toll. But even after he had a stroke, I think it was '67, he lived 10 years, and then died suddenly of a lung hemorrhage. He was a tough old bird. I mean, with all the stuff he had to put up with, and operating really with half a lung. When he was active, he went golfing. He did lots of outdoor work. After he got out of the mines, he was a logger. He had a timber limit and a truck, and I spent a lot of time in the bush with him, helping him with the older brother and a cousin do this big cedar tree logging and fencepost cutting, and all of that good manly stuff.

ZIERLER: When did you start to develop an interest in engineering, and science, and math?

LARSEN: I was always interested in technical things, and not very sophisticated stuff. I remember trying to take a radio apart at times, but I had no idea what I was doing. And of course, with radios, everything was tubes. Everything was high-voltage. There were no transistors. I was always mechanically inclined. I had bikes I liked to take apart. Well, you had to take them apart. If you didn't know how to take your bike apart, you had no business owning one, [laughs] because they were always breaking something. Something was always breaking. But I was mostly interested in aeronautics. There was a little airport near where we lived. We saw occasional planes, and of course, in wartime, we got a whole dose of incredible technologies that were happening during the war. I mean, the war broke out in1939 when I was 5 years old, and I remember we had a big radio, and every night at 6:00, we got the BBC News, and they were under siege by the bombing of London and so on. And we were glued to that radio. That was our main source of information, really. But in general, I liked model airplanes. I built a lot of models a few of which actually flew on their rubber-band motors. (One older rich kid in town, an only child, built big scale models with real motors and his parents drove him down to the States to join competitions.) To me, I was going to be a pilot or an aeronautical engineer, one of the two. And the only reason I wasn't, I think, is when it came down to actually going to college, the only place to go get that kind of a degree was down at someplace like Caltech. And I think University of Washington had an aeronautics program. But we just didn't have the money. The system in B.C., like most of Canada, is a provincial government curriculum. I guess it's a government curriculum for a province. I don't know that every province is identical. Not these days. I'm sure they're not. But in those days, there was a set curriculum, and you had to take it, whether you liked this stuff or not. You know? [laughs] You took math, and you took physics, and whatever else they could throw at you in high school. And I did well in all the technical stuff. I guess I was sort of the top of the class for a long time. But I was no real genius at it. I guess in a small town, they thought I was. But when you get to the university, you find out [laughs] there's just a ton of people that are just as smart as you are, if not smarter.

ZIERLER: And what were your options when you graduated high school? What were you thinking about doing? Where were you thinking about going?

LARSEN: Those are really the only places I thought about going, was going to the States and do aeronautics, or go to UBC, which at that time was the only university in the province. Now there are several, but at that time, there was just the one. And I had relatives down there. I mean, I was very happy to go there, because a lot of our relatives lived in Vancouver. (Two of the brothers with silicosis moved to "The Coast" for health reasons, along with two other brothers who were commercial fishermen and two younger sisters one of whom had her own business in downtown Vancouver, so this was a Tribe of really great family. As the first one to attend university they treated me like royalty.) So, there was no big debate about it. Plus, I had several close friends in high school, and we all stuck together and went in and registered. We drove down together and registered together. So, it was just a homey place to go, and with all the advantages I had and lots of relatives that I really liked — and my grandmother was still alive, and her daughters — business owner, and just a slew of them. They had great family gatherings. So, it was great.

ZIERLER: And when did you declare the major?

LARSEN: Well, the way the system worked is you got — engineering was a 5-year class. The first year was the Arts. The same as all — the Bachelors of Arts students would get the same courses. But in Engineering, you took the arts first, because once you got away from it, you were going to miss out on a lot of basic important stuff. So, you had to do that first. And then, you went into engineering, which was a four more years to the degree. And I had no hesitation whatever to sign up for Electrical — the two choices would have been electrical and engineering physics, but not chemistry. I did not care for chemistry. [laughs] But electrical — I think I got interested in electricity during my high school years, because they did have seminars for — people from the district would come to the high school. I had to go to another town to a big enough high school to get this. But this was just like an outing, where they had — you know, it was kind of a, "What are you guys going to do when you grow up?" kinds of classes. And one of the speakers was a guy from the power company. This whole, big area has a lot of huge rivers and big power dams, and when he was through talking, I thought that was a pretty terrific job that he had, and I got —that was a piece of information I had when I headed to college. I couldn't think of anything else that I liked any better. In the first two years of engineering we got a dose of everything. For two years we got math, chemistry, physics, mechanical, civil, mining geology. We got a dose of all branches engineering. Plus we had 2-week summer classes after everyone had gone home for things like land surveying. And let's see — what other stuff? This was like, civil stuff. And we had another summer class which was sort of 3-D geometry drafting, for mining engineering. And we did take also special courses in drafting so we could actually go out and make a living quite easily as a surveyor or a draftsman, and that was a pretty good job. And I did that in the summers, as a matter of fact, to earn money for the next year of study. So overall — and we also did get chemistry, which I thought was not too bad until we got to this — what do you call it— anyway, this is what I'm telling you, about the mental block once in a while. (I was trying to say Organic Chemistry!)

ZIERLER: That's alright.

LARSEN: This particular breed of chemistry did not sit well with me. I could never get the labs to work out. [laughs] Then we had these crazy lab teachers, who were really teachers' assistants. And they were a bit strange — one of them, I remember his main technique was that he left you alone, and if you didn't like it he kept saying, "Well, if you want to do it or not, I couldn't care less." [laughs] So, not very inspiring.

ZIERLER: Now, what was the other option? Electrical physics, is it?

LARSEN: Engineering Physics.

ZIERLER: Engineering physics.

LARSEN: Yeah.

ZIERLER: Did you try your hand at that?

LARSEN: No. Well, we had some of the same classes. But Engineering Physics was what it says. It was a big dose of Applied Physics mainly, and it was considered the toughest engineering course in the whole university, and probably still is, because you do everything. You do a lot more analytical stuff. I found out in doing my Master's that I was not going to be a great analyst. You know, calculus was no problem, all that earlier stuff I managed very well. But then when we got into this more abstract statistical stuff, numerical analyses and all kinds of series functions, manipulating multidimensional matrices, I don't know. It just didn't [laughs] break through my thick skull, and I decided I don't want to do that. I don't want to get into that very deeply. I'm just not going to be any good at it.

ZIERLER: Was there a senior thesis that you had?

LARSEN: Not in undergraduate, but I then took a Master's, and there was obviously a thesis for that.

ZIERLER: Did you go straight into the master's from undergraduate?

LARSEN: Yeah, I did.

ZIERLER: And where did you go for your graduate school?

LARSEN: I went to the same school, at UBC. The way that happened is I did very well in the EE class, near the top, and late in the year a senior professor came up and said, "You know, you ought to apply for a bursary to go to grad school." And so, I did, and once I did, that was kind of the way it's going to go. Incidentally, right after I graduated from the bachelor's degree, I got married, at the ripe old age of 22. Which, my Dad thought was ridiculous. But anyway, he went along with it. [laughs] He didn't have much choice. But by the time I was in — oh, I should say during the time I was in the Master's degree, we also had our first child, which wasn't exactly in the plans either. But back to your original question: was there a thesis? Yeah, there was a thesis in the master's program, and it was like — my advisor was a German professor who had done a lot of work on the German side during the war in things like flight simulators. He taught a class and was a really brilliant guy. But he was also into computing, so at that time, we had — when I first started UBC, there was no such thing as a computer in the facility. The first computer came in when I started grad school, and it filled a huge room, all built out of tube technology — vacuum tubes. So, I got hooked up with this professor, and he was interested in — see, the computers, I guess, were very limited, and he thought that a combination of analog and digital computing would go somewhere. I think he was a little ahead of his time, because later, in the instrumentation we did around SLAC, for example, it was all very fast analog ahead of slower digital. You needed fast front-end reaction to nanosecond events, and that's analog. And you've got to stretch that out in time to make it digital. And my thesis was a part of that. It was *An Integrator for a Pulse-Position Modulation Analog Computer.* And of course I had to build it out of tubes and test it. That was my thesis topic. So, it all seems pretty arcane and mundane at this point, but — it served the purpose.

ZIERLER: What year was this? What year did you defend your master's thesis?

LARSEN: '58. Yeah. Old.

ZIERLER: [laughs] And then what were you thinking after graduate school? Did you consider going on for the Ph.D. right away? Did you want to enter industry?

LARSEN: I couldn't wait to get out of there and get working. [laughs]

ZIERLER: That was enough school for you.

LARSEN: Well, yeah. I mean, here's what you're up against. When I went to high school, you know, we started off as a class of, I don't know, 20 or so. And in high school, 10th grade was mandatory.

[30:00]

You had — every government said: you've got to go to 10th grade, which I think is great, because today in India, it's grade 5. This is what you have to do. And then the teachers never show up, and you know, it's just a charade for people to end up on the farm. Anyway, sorry I just lost my little Choo-Choo train of thought…

> *Ray clarified later on:*
> What I was trying t say was that in high school after 10^{th} grade finished 2/3 of the class quit school to join the post-war industry boom. Only the hardy or foolish kept going. But in our remnant class almost everyone got university degrees. But with the Master's adding two more years to five years of Engineering, and having a wife and a baby to support I really had to get to work

ZIERLER: That's alright. I was asking about what your interests and prospects were after your defense of the thesis.

LARSEN: Yeah, yeah. What I was looking for — in fact, even while I was in school working on the thesis , I got signed up for my job in research at the big laboratory in Quebec City. I had spent a summer before the Masters working at a similar but unclassified lab in Ottawa.

ZIERLER: What was the research laboratory?

LARSEN: Well, I joined a Microwave Group in a Lab called Canadian Armament Research and Development Establishment (CARDE), also called the "Fourth Service" of the military. The lab had an ultrasonic projectile range, solid fuel rocket program, high altitude balloon microwave spectroscopy program. A very large range of other programs, almost all classified Secret. It also collaborated with similar labs in the US and UK (Tri-Partite Agreement).

ZIERLER: And this was a government laboratory?

LARSEN: Yes, entirely.

ZIERLER: Was this a limited-term appointment? Were you a full-time employee there?

LARSEN: Absolutely a full-time employee, yes. Could have spent my life there.

ZIERLER: And how long did you stay there?

LARSEN: I stayed four and a half years. That's when my daughter — the oldest child, that was getting to be ready for school, and we were at that time in a totally French-speaking part of the country, and the school system for English speaking people in that part of the country, in Quebec City, was not very strong. So, we had decided we would leave westward closer to our families when the daughter got ready for school. Not that it would have been a tragedy for her to stay there for some time, but it just seemed I was not very happy with the rate at which things moved at the Lab. It seemed like — you know, you do a lot of really good work, and you think maybe you'll get something more than the standard raise for it, but it never happened. It just seemed like locked into a rigid system. I said, okay, this isn't really opening up anything for me. And the Heads of these groups were mostly physicists with PhDs who were also academics. That was their main background, anyway. And I just didn't see myself ever getting a senior job. Of course, I'd done only four and a half years, but I covered a lot of ground in those four and a half years. I did apply for a couple of jobs in the US, one at a new Radio Telescope back east and another at the big nuclear lab in Idaho which would have been an ideal location, but instead they offered me a job at Argonne in Chicago which was not of interest. The reason for moving east in the first place was because there were no research jobs in B.C. It was looking pretty discouraging. But one wintry day, I saw an ad in the Montreal Gazette from SLAC. The IEEE used to hold a huge meeting every year in New York. It was kind of like the big meeting of the year, and SLAC was barely starting up. It was all in one 2-storey metal building at the time down on the Stanford campus. But they sent a recruiter out, and the recruiter turned out to be an ex pat Canadian guy from Montreal. So, I'm sure that's why he went to Montreal, is because [laughs] he wanted to visit his old home.

ZIERLER: And what year would this have been?

LARSEN: That was —

ZIERLER: '63? '64?

LARSEN: Very early in '62.

ZIERLER: '62. Okay.

LARSEN: Very early, like February.

ZIERLER: Okay. So, you first saw the ad, and then you met the recruiter.

LARSEN: Well, I saw something before I saw the ad. I subscribed to *Scientific American*, and I had read all about SLAC in a recent article written by some of the people I later got to know, and it was quite fascinating, because it was all of the kind of technology that I was pretty steeped in by that time. So, I thought: this is maybe the chance. So, I went to this interview. We drove through a blizzard to get to this interview. So, it's about 200 miles between the two cities — 150, maybe. It was a long drive in a blizzard. So, I go to this hotel room where this guy's having his interviews, and he's just kind of a mild-mannered little guy, and he was not an engineer. He was a recruiter. And I had what I think was the worst interview in my life, with this guy, and I thought: we're just not connecting. It's like he wants new people, but he wants people with a ton of experience at the same time. And I said: well, look. I've got a Master's in this field. I've got four and a half years' experience doing similar work to what you're doing. What are you looking for? I actually chewed him out. I said — you know, because I was just being blown off. So, I said, "What are you looking for?" I went out of there and said to my wife: well, that was a nice trip.

ZIERLER: Well, how did he answer you? When you asked him, "What are you looking for?" what did he say?

LARSEN: He just smiled. [laughs] I mean, it's like, "Well, isn't it obvious what I'm looking for? I'm looking for some perfect candidate, and it's not you." [laughs] I mean, that's the message I'm getting.

ZIERLER: So, you left there. You did not get the job. This is what you're thinking.

LARSEN: I left there saying, "Yeah, forget it." But luckily —

ZIERLER: Ray, were you really excited by this?

LARSEN: Yeah.

ZIERLER: I mean, did SLAC sort of capture your imagination.

LARSEN: Yeah, right away. Yeah. I thought it was perfect! Well, and also Stanford, because I could pick up on my education again at Stanford.

ZIERLER: Right. What was it about SLAC? I mean, circa 1962, what was so exciting to you, reading about it in *Scientific American*? What did it mean to you?

LARSEN: Well, it was unclassified. It was new. It was science. It was, technically, tremendously exciting. I just couldn't wait to get there. But there was this [laughs] little guy standing in my way. We shall not name, but he's a very nice guy. And I knew him for many, many years after that. (Later his claim to fame at SLAC was that he had hired both me and another guy who became head of Controls on the same trip.)

ZIERLER: By "little guy," I assume we're not talking about Pief Panofsky, right?

LARSEN: No, he wasn't that little. [laughs]

ZIERLER: [laughs] Okay. Just checking. Had to ask.

LARSEN: No, no. This guy was — no, Pief would have hired me right on the spot. [laughs]. But this guy — the good part of the news is, when he got home, people looked at the reports, and they'd look at the resumes. And I got a phone call in a week and I was out there in a couple of weeks. I was out there getting interviewed.

ZIERLER: What was the job, exactly, that you applied for? What was the title?

LARSEN: It was nothing fancy about the title. It wasn't a leadership position. It was a staff engineering position in the Instrumentation group. But they liked my combination of cutting edge microwave, radar and circuit design experience.

ZIERLER: Now, was your sense that this was a new position, or were you replacing somebody?

LARSEN: It was new. I mean, they were just hiring like crazy. This was all new. And it was totally international. An office-mate from Connecticut grumbled one day, "When the heck are they going to hire some Americans around here?

ZIERLER: And this was to manage existing systems, or you would actually be part of building instrumentation?

LARSEN: No, this was to design new stuff. Everything was in a design mode. There was nothing ready to go yet, and I think one of the first jobs I had was to design an instrument to measure Perveance of a klystron which is the heart of the RF drive system. SLAC has (or had) 240 klystrons. Perveance monitors were used for lab testing new tubes. Second I worked on the laser alignment system for the whole accelerator. That was a separate job. For tests they had an old railroad tunnel that was about a mile long, and they set up there to test the concept of a Fresnel lens between a blown up laser beam source at one end of the support pipe and a frosted glass screen at the far end. The total accelerator would have 30-300ft sectors with ability to remotely drop in a Fresnel lens at the 30 end points. The image at the far end was an upright cross that was then scanned with a phototube to determine the XY position to 1 mm which was then brought into line with wrenches. I designed and built all of the electronics scanning and readout system.

And then,— and they had a little team starting to do this already -- I was assigned to design a beam position and charge monitoring system for the whole machine, and that meant a position monitor and a toroid charge monitor every 300 feet or once per Sector. The position monitors were just little microwave cavity sections, with RF X and Y pickups between Sectors of the machine. So, you had to capture and sample the pulses to figure out X-Y coordinates of the beam at that particular spot, all part of the steering system for the beam itself, that is steered with DC magnets to trim X and Y, and the operator has to adjust them remotely to keep the beam straight down the center of the pipe. So, I did the first system for the entire machine for that, for both the position and the charge monitoring a parts of it. We made some fairly novel stuff, because we got — again, it was fast sample-and-hold technology, and how well can you make the analog stuff work? And one of the biggest problems was the hold- time of the sampled peak pulse that you need to display. You take a sample, and then it dribbles away. How do you hold it up? Well luckily, people down in the Valley, one of my Stanford EE Profs in fact, had just invented and marketed new Field-Effect Transistors (FETs). And the field-effect transistors were the dream solution to that problem, except they were so delicate, they would blow up on you if you looked at them the wrong way. But they got better with time and we used them widely. So I glommed onto that piece of technology, along with some fairly fast — what did they call them? They're sort of bi-directional switches. (Dual Emitter Chopper Transistors). And that's getting a little ahead of myself, because when I started taking classes toward another degree part time on the so-called Honors Co-op program, and I started learning about these other devices like FETs and the dual-emitter chopper transistor and immediately put them to work in my designs . And I actually did a Degree of Engineer thesis on it as well, but I was able to build circuits that — I mean, the hold time was just phenomenal. It was just like, many, many milliseconds hold-time, and you didn't need that much. So, that was recognized as a very successful project, and it didn't hurt my reputation any.

And as soon as that was done, I thought: well, the machine build is coming to a close here. They said the job would last five years. They had the machine running in four years. But when I hired on they shad aid at the end of that time, you know, that's the end of your job.

ZIERLER: Yeah.

LARSEN: So, I'm starting to look around for jobs, and Burt Richter popped into my office one day and said, "Where are you going? We've got all these Detectors to instrument." [laughs] "We've got all this stuff to do in the end Stations." So, okay. What do you got? He immediately made me head of a two-man group to look into some of the systems that the lab needed for the instrumentation of all experiments, nanosecond pulse logic modules, general -purpose interchangeable modular stuff. So, I became the daddy of the High-Energy Electronics Pool (HEEP). (Shortly after that I got a stream of challenging jobs from Burt including the 1% accurate non-intercepting beam charge monitor for the End Station, a first of its kind, the first multi-wire proportional X-Y array after the recent design by Charpak of CERN who won a Nobel, and when we had grown to large group we supported a cluster of large detectors, the crowning one being the SLAC SLD detector co-led by Marty Breidenbach which revolutionized on-detector instrumentation with new imbedded custom integrated circuit solutions to eliminate huge cable plants and the off-detector FASTBUS standards with fiber optic data collection systems.)

ZIERLER: Now Ray, before we get to that next phase, I want to ask you: in the early years, give me a sense of what a day looked like, especially when everything was in the design phase. Was the atmosphere chaotic? Was it orderly? I mean, who were you getting your orders from? Who were you working with? Just give me a general sense of how an average day went in those early years.

LARSEN: Well, let's see. In the early years, we started out in this one building down on the campus. It was called the "Project M" building, and "M" stood for "monster." You've probably heard that one already.

ZIERLER: [laughs] I have. Who was the monster, though?

LARSEN: No, the Monster was the accelerator.

ZIERLER: That was it?

LARSEN: They had already built a 300 ft. section of it on the campus, and that was just a little 1/30 of what they needed for this machine. So, it became "The Monster." I worked directly for a guy named — well, I want to say Karl Brown, but there was another engineer in there under Karl, who was very active in the controls field. This is where I thought I would have problems, remembering all these names. Larry Johnson became the head of the controls department. But I worked initially in a very small group. I was not the group leader. I worked in a small group that was working strictly on these particular position and charge-monitoring problems. And I think there were maybe three, four engineers in the total group doing other instrumentation. But as far as — and then fairly quickly, it seemed that we moved — they were madly building the first buildings up at SLAC, so as soon the first Office building as that building, and the klystron test laboratory were finished we moved. For lab work we shared a small piece of the klystron test lab for evaluation of new tubes built by three different companies. This occupied most of the building, and the klystrons were, electrically, horribly noisy for our low-level circuit work so we spent a lot of time learning how to deal with it, because that would be the environment for all circuits in the accelerator. We didn't spend that much time down below on campus after that, but the initial work I've been talking about mainly took place in the building on the campus. But the people —down on the campus I just loved the people, because they were — the best part of SLAC were the physicists who, to a man — or woman — were extremely brilliant people, but they didn't act like it. They acted like: hey, we're just one big team here, and you're all important. And that was Pief's mantra. His door was always open. He would talk to the janitor. He didn't care who walked in. And that became — it's not just Pief's mantra, but other people totally bought into what he was all about. Engineers were equally respected. In many labs there was and probably still is a class distinction between physicists and lesser beings which is what Pief and his team actively opposed.

ZIERLER: Now, in terms of the chain of command, what was your sense of who set the tone for what should be accomplished and when? Did that all originate with Pief, or was decision making more decentralized?

LARSEN: ____ started on-site construction on the sections of the machine and all of these things. And they — are you still there?

ZIERLER: We're back now.

LARSEN: Oh, we're back. Okay.

ZIERLER: Sorry about that. So, I don't know if you heard the last question. The last question I asked was about the hierarchy, about the decision-making hierarchy.

LARSEN: Yeah.

ZIERLER: So, I didn't hear — that was my question, but I didn't hear any of your answer to that.

LARSEN: Well, there was a well-defined hierarchy. I mean, Pief had deputies, and in the Physics Division he had group leaders. And the group leaders, guys like Richter and Taylor and Ballam others, who were driving the physics end of it, but they were also taking an immense interest in everything that was going on in the Technical Division under Richard Neal with the critical accelerator construction done on site in the ME Department, while work on all power systems and controls went on under the EE department where I was a member. There were constant challenges — everything was new, so you didn't quite know how it was all going to work in scaling up the prototype by 30X and two miles. Everything was a challenge.

ZIERLER: And your sense was that the deputies and the group leaders were empowered to make their own decisions. Pief was not managing everything on a granular level.

LARSEN: Certainly not. But he was also an off-the-charts smart guy, and he had opinions about everything. [laughs] And people listened to him. But he was not a command-control kind of a guy. He was always smiling. He often quoted Einstein that *"Every problem should be made as simple as possible – but not simpler!"*

ZIERLER: And was your sense — was there an overriding, singular mission that SLAC had, and you saw yourself fitting into that overall mission? Or, were things more stove piped than that, and there was different groups, and they had their own missions?

LARSEN: I think Pief made it one mission. He made it one mission, no matter what was going on. It's all part of the total mission of the laboratory.

ZIERLER: And what would you say that mission is, if you could characterize it?

LARSEN: Well, to be the best. We're new. We're exciting. We've got stuff to prove, research to do, and everybody's optimistic about the future. I mean, it's pretty intoxicating.

ZIERLER: And what were some of the really exciting discoveries that people were thinking might be on the horizon as a result of what was happening at SLAC?

LARSEN: The physicists would answer that in great detail, and I cannot. I know for me, what was exciting was to make sure all experiments were running exactly the way they're supposed to, and that they have high up-time, and they don't have a lot of stuff breaking, and everything is smooth. And if there's a problem, you were there in the middle of the night, whatever it is. And that's the job— you don't complain about it. You're just really totally dedicated to it.

ZIERLER: And in terms of the work flow, where do you fit in, in terms of — there's the physicists that want these experiments to go on in a particular way. Are they communicating this directly to you? Are there in-between people? How does that work?

LARSEN: As soon as I got to be heading a group and so on, all that communication came directly to me. There was no middle people second-guessing it, just a lot of new stuff. Marty Breidenbach is a perfect example of a guy who's — he's got great ideas, and he's very interested in the technology, and so he's always coming about and saying, "Can't we do this? I mean, what would it take to do this?" And that stirred us to take it on and think about it. There was no "take a ticket and get in line"; we would start the process of coming up with an approach. I mean, it was very democratic, I'd say. And all the big experimental leaders, same deal. I knew they were heads of major projects, and I talked to all of them directly. And that's how we did business. I didn't have to ask anyone's permission to do this, only later when it came to assigning resources and spending somebody else's money.

ZIERLER: And in terms of assessing the success of a given experiment, how does that work in terms of — what are you looking at with regard to how an experiment is going, and how are you communicating that back to the physicists?

LARSEN: When everything is running smoothly, and all the instrumentation is running, there's not much for me to do except hope it keeps running. It's not like — I mean, if I see something that's not working right, I'll have a program to fix it immediately. All experiments have operators who can deal with operational problems but if somebody's got a real problem, they will call our maintenance people and I'm going to hear about it, and we'll react. We've got to— that's our bread and butter, is to serve those customers well. They're all customers. I'm responsible.

ZIERLER: And you're responsible for these experiments that are really the first of their kind. So, there's no playbook that you're relying on, essentially. You're really making everything up on the fly.

LARSEN: Yeah. There wasn't a playbook for any of it, and I couldn't really compare it with other labs, because other labs were totally different. I mean, they're managed differently. They're operating differently. We just had our own group, which tried to give our best service from design to fixing what breaks and I think to this day we were among the best.

ZIERLER: [Chuckles]

LARSEN: No, I'm talking as an ordinary engineer. SLAC succeeded in making everybody feel important. And I say Pief was the main progenitor of that, but the others were very approachable. I could walk in and talk to any of them, anytime, and vice-versa. They were just great people; they're not personal friends, but they were just really great to work with.

ZIERLER: In terms of the physicists that you worked with, were most of them full-time at SLAC, or would there be people that were coming in from the department, from the physics department at Stanford as well?

LARSEN: Yeah. Well, people are coming in all the time from other places. I mean, there are university groups that are running experiments too. Like right now, there are some new experiments planned for the tapping off of the new beam from the upgrade, this _new CW machine that we're currently building.

I'm sure you know about it. And there are people tapping off that beam to do novel experiments that have nothing to do with the upgrade experiments. But they divert a small slice of the beam into one of the old end stations, End Station A, and they're doing —

(working toward) a Gigavolt GeV accelerator on a tabletop. Burt had always pushed that line of research. So, what does it take to do that?

ZIERLER: I think, let's see — where we were was in terms of you — there being no playbook, and you were just devising this on your own. Oh, and the last thing was physicists coming from all over, not just physicists from SLAC.

LARSEN: Yeah. So, they were typically from certain universities SLAC has had a lot of collaboration with, and I think Caltech and UCLA are major ones, but many others as well. There's a group there now planning experiments that are designed to basically, eventually — with lasers and solid-state acceleration of the electron beam, they can actually achieve GeV acceleration in a solid-state medium. And Burt always talked about building a GeV accelerator on a tabletop. And this next line of research is aimed at that type of technology. I know only what little I've read in the proposals. There's also an Attosecond experiment planned that I'm supposed to be helping out with. When I say "helping out" at this stage, it's basically to help on the management side of finding people to do the work and dealing with budgets and schedules if help is needed, and that sort of thing. I'm trying to avoid getting into anything more than that because of my other full-time job, [laughs] my volunteer job.

ZIERLER: Which is what? What are you doing?

LARSEN: I'm Chairing IEEE Smart Village, which is a big humanitarian non-profit involving many people, to fund new startups in very poor countries to help eliminate the worst of world poverty by 2030, in support of a United Nations program called Sustainable Development Goals. I I co-founded it 10 years ago, and am stepping down as Chair for someone to take it to the next level. (smart.village@ieee.org). IEEE at 430,000 members is the largest professional engineering group in the world and we are mostly supported by IEEE Foundation and 39 Technical Societies, one of which is Nuclear and Plasma Sciences which runs major conferences in accelerators and instrumentation among many others. I am a Past President of NPSS as well as a Fellow since 1988.

ZIERLER: When did you retire from full-time at SLAC?

LARSEN: November of 2014.

ZIERLER: So really, from 1962 to 2014, you were there full-time continuously?

LARSEN: Except for my seven-year sabbatical to Silicon Valley to do a startup company.

ZIERLER: Ah! What years was that?

LARSEN: '88 to whatever — '95, I guess.

ZIERLER: And what was the company?

LARSEN: It was a high-speed instrumentation company called Analytek Ltd. The launch product was kind of an oscilloscope, but it's not just a scope, a system product based on the VME modular standard with multiple channels of 2 GHz waveform sampling which was very hard to do at that time. Today, the field has come a long way, and you can do a lot of this stuff on new integrated circuits that we did with our SLD analog to digital technology. You can do more of it straight up digital. But that was in 1988. I I'm a co-owner of the patents on the fast waveform capture chips that we took to commercialize because we thought: that's part of what labs are supposed to be doing. So, let's give it a whirl. And I didn't want to hang onto my old job, although in retrospect, perhaps I should have. But I said if I'm going into this, I'm going to do it whole-hog. So, we did it, and we —

ZIERLER: So, you were going to go into it whole-hog. You thought in retrospect maybe you should have held onto your old job.

LARSEN: Well, the reason I say that — I don't regret going on it whole-hog, because unless we did we could not get investment. But I had built a pretty good empire at the lab, and I might have known, when I quit abruptly, somebody would shred it, and they did. So, I felt really badly for a number of people who were dealt with very shoddily to put it mildly.

ZIERLER: Why? Why would it have gotten shredded?

LARSEN: Because there's opportunists around who like to do things their own way, and hey, here's this big headless plum sitting here. Let's get it our way. Let's get rid of the people we don't like. Change all the things they never told you that they didn't like about your organization, but mainly chop it up and chop people off. I understand that might make sense if they could not find a replacement but I don't think they tried.

ZIERLER: [laughs] Right. Opportunity.

Okay, so the question: absent those seven years, I wonder, just sort of in your mind, how you might divide those eras at SLAC. I mean, you know, in decades, in terms of directors — what are the big ways — if there was a book with chapters that was about your time at SLAC, how would you divide those chapters?

LARSEN: Well, I think the early days would just be getting settled in and discovering not just SLAC, but the University and getting involved with another study program with some of the best Profs on the planet. I went part time about six years in that total program. And in four years basically, we had done the first wave of our major technology job, and then we were immediately put into the job of instrumenting detectors. So, that's another major chapter.

At the beginning, it was a straightforward job of buying equipment, modular equipment, but then discovering that — well actually, that happened very early when I was still on the Stanford Campus when contacted by counterparts from UC Berkeley and the National Bureau of Standards, who were tasked with inventing a standard modular technology for nuclear instrumentation, the so-called NIM (Nuclear Instrument Module) system. So, I got a visitation about that very early, and I think it was because I had been active at IEEE in Quebec that they tracked me down somehow. Probably thought, "Well, this guy's a patsy. Let's get him involved." So, I got involved with that effort, and when we started out buying everything as best we could for the first experiments at SLAC, we also discovered that a lot of it was junk, and the designs were incompatible in the choice of signal levels — they weren't using a standard platform, so stuff was all over the map. The NIM development was launched by the government (AEC, predecessor to DOE) which was spending millions on nuclear reactor programs with a half dozen totally incompatible commercial platforms. So the group put a priority on getting the standards together in a common chassis and specified signal land power supply levels. So, we thought it was good for experiments but also for vendors who adapted to building interchangeable modules to plug into the same frame. So that's what that was all about, and I NIM was pretty simplistic in its way. This was before we had the much greater complexity of the digital stuff and data buses; we started out in the nanosecond pulse analog world. And NIM worked very well, because there was no big communication problem between modules at that point. As soon as it went digital, it became another world, and that was the CAMAC world.

And since this was an initiative from a major customer, the National Bureau of Standards under AEC we thought we were doing the world and ourselves a favor to get more vendor interchangeability.

Most recently I chaired the newest collaboration on the latest round of standards, ATCA and MicroTCA, now in full-scale use at the new DESY XFEL light source and in some smaller other labs as well. The DESY team were the main drivers, and they now also have initiated a Development Laboratory dedicated to extending usage amongst the other labs and manufacturers. Anyway, standards have been a major part of my so-called career at SLAC. After NIM came the digital data bus version CAMAC, and then a much faster data bus architecture called FASTBUS for which I was also the technical manager. This was all National Lab and European Collaboration, but only CAMAC became an IEEE, ANSI and ESONE (European Standards on Nuclear Electronics, now defunct). So, I got used to the idea that for any of these machines done with government money the engineering community should strive for standardization that keep up with the new technologies, , and no single laboratory can do a decent job. We need to collaborate and share knowledge and effort for global benefit. We also need to get industry involved from the beginning to get buy-in and well-engineered solutions.

In the pre- standards days all jobs were customized by individual engineers and physicists who developed special niches which only they understood. And the the stuff they produced was custom designed including the mechanics which EE's do very poorly, so the new modules were a godsend in that the platform became lab-wide and EE's were told to design within the standard. CAMAC still runs the SLAC copper accelerator today and a new standard from the Telecom industry adapted to physics use called ATCA is running the new superconducting LCLS-II now under construction.

When I got management responsibilities, I very much pushed for standards in all the laboratories. And in the early days people like Burt and Dick Neal and others really supported it and provided funding out of their DOE operating budgets. They thought this is the right thing to do. And it wasn't my or SLAC's private domai**n.** Standards have played a major role in t most major labs and my Department at SLAC played a major role in developing and applying them.

But not everyone agrees on their use. Some say they could care less about new standards; thy want the cheapest solution which means the status quo. This has led to some tension but that's more about which standards to use. The old stuff still works, why change even if t's technically outmoded and a poor choice for the new technologies?

ZIERLER: I mean, it sounds like a crazy question, but it's almost as if it's controversial for you to be pushing standards. How could it be any other way?

LARSEN: How could it be any other way —you mean, there's always controversy?

ZIERLER: Yeah.

LARSEN: Yeah. Yeah, it's not a surprise that people resist change. It's just annoying. [Laughs]

ZIERLER: [laughs] Yeah.

LARSEN: Seriously, the Project Managers have to make the choice and anything new is a risk and we have to assure them through demonstration that we have all the risks under control – technical, resources, cost, schedule, supply chain --and like any sales situation you can't win 'em all. But we did win a lot. On the other hand, in a multi-purpose lab like SLAC has become, upper management needs to take a stand on standards that are best supported by the lab as a whole, not totally left to the Project Manager du Jour. Support of multiple systems is a huge maintenance burden on the lab and creates silos of specialists.

Obviously I was steeped in standards development from almost the time I walked in the door at SLAC and y got involved in collaborations with the leading brains from National Bureau of Standards, Lawrence Berkeley Lab, Lawrence Livermore, Fermi, Argonne, and Brookhaven Rutherford, CERN, DESY, Saclay, Orsay, Los Alamos, TRIUMPH, IHEP, KEK plus others and many companies supporting the development work. These relationships filled a very rich side of my life representing SLAC especially when it was the new kid on the block and everyone was very eager to hear about it.

ZIERLER: Are there times at SLAC that stick out in your memory as being particularly exciting and full of discovery, more than others? Or, is it more like a steady flow?

LARSEN: Well obviously, when the Nobel Prizes pop out, those are very exciting events. [laughs] And then we've had several of them. Right? I think I know of five Nobel laureates. All of them worked at SLAC, or used to work. I don't know that any of them are still alive.

ZIERLER: But that's looking back, retroactive, when you see that the Nobel Prize was won. But could you — in terms of the research itself — right?

LARSEN: Yeah.

ZIERLER: Did you get a sense of projects that were, you know, "Hey, I think this is Nobel Prize stuff."

I mean, did you get — was that energy — did you feel that in terms of particular projects and stuff that were real game-changers?

LARSEN: No, because I'm not informed enough to be able to pick between projects, which are more promising than others. I think they were all promising, or they wouldn't be happening. My team's work was most satisfying when it supported all experiments with maximum up-time because beam time to the experimenter is the most precious resource.

ZIERLER: Right.

LARSEN: And I was on alert for fantastic results from any of them. You just never knew. And the other thing that really turned me on is that the lab leadership planned ahead, and it seemed to me went quickly from one machine development to the next. How about a circular machine and colliding beams? How about SPEAR as a light source for industry experiments after its life with colliding beams? Today they're booked to the gills with outside customers. And today we've also got Kavli Lab for astrophysics and the relatively recent discoveries of Dark Energy and Dark Matter making up80% of the Universe? And now, it seems there is a great synergy of the submicron research and the intergalactic — the search for understanding dark energy and dark matter fundamental structures and how all of and all the processes going on everywhere are ultimately related. So the scope and the interest level of this laboratory as a whole is just phenomenal. I really enjoy that perception.

ZIERLER: Now, you have — I mean, given your tenure, you have a special vantage point in thinking about the leaders from Pief all the way to Persis Drell. And I wonder — the overall question is: do you tend to see more continuity or more change with leadership at the top?

LARSEN: I think there was a lot of continuity, up to the point of the more recent ones. And the lab has made a huge shift in fields of interest which began with new ownership by NRC with the LCLS light source programs that began under Jonathan Dorfan. I worked for Jonathan under the PEP II program that he managed and also LCLS-I while I oversaw both Controls and Power Conversion Departments, in which we performed very well under stressful conditions. Jonathan was also championed SLAC to be a Respectful Workplace, taking a leaf I from Pief's playbook at a needed time.

ZIERLER: So, in terms of when Burt Richter took over in 1984, you saw what he was doing. His mandate was essentially to continue what Pief had built.

LARSEN: Yeah. But they had their own ideas, and they — Burt was a very innovative thinker, and one of his big, new ideas was — we're still haggling about is that, you know, the Next lLinear Collider. He worked this out with his counterpart at KEK in Japan, and proposed this whole concept of the 20-mile long l TeV NLC after the existing SLAC machine.

ZIERLER: And the next linear collider, that was beyond Pief's scope. That was beyond what he was concentrating on. That was too far into the future from his vantage point, as far as you could tell.

LARSEN: I can't remember exactly what the overlap was. Was Pief still around when NLC started getting some real attention? I don't recall. I was heavily involved in the NLC program as co-leader for conceptual design and cost estimating for both Controls and Klystron Modulators. And I was directly involved in promoting and building the Solid-State Modulator solution which our Power Conversion team designed in collaboration with Lawrence Livermore Lab. Modulators and klystrons were two major cost drivers for NLC. I; the proposal is still alive in Japan but I'm no longer involved nor up to date. It's been a dream for about 30 years now. We did build a very successful new solid-state modulator but it's still in a test lab. (This is all rather moot now since SLAC no longer has a High Energy Physics program.) **ZIERLER:** To what extent did the main agenda come from within, and how much of it was influenced by outside physicists? In other words, you talked before about groups coming in and all kinds of ideas, but in terms of the big strategic questions about what SLAC should be devoted to looking at, where did you see most of those big decisions coming from?

LARSEN: I think the big decision's came internally, but to what extent were there externals or impact? I mean, physics is a big giant mosh pit, right? Everybody's got many interest that tend to align with large new initiatives, and I think no matter where you go in the physics world, you'll find people supporting all kinds of stuff especially if it's setting a major new direction that a lot of people can get involved with, including multiple labs and universities. And I think that's just built in. It's broad. It's highly competitive. It's taking everybody's best ideas and saying, "Where do we fit in? How can we best help?"

ZIERLER: And in terms of the constellation of national laboratories, what did you see as some of the closest partnerships that SLAC had with other national labs?

LARSEN: That's a very good question. Currently SLAC has many collaborating labs, three major ones for building the current LCLS II superconducting accelerator and many others as well. The SLD detector with Marty and Charley Baltay was a hugely successful collaboration.

On the electronics side of the field we've closely collaborated with a dozen major labs on standards starting with NIM in 1964. I served as the nominal EE guy on the US ATLAS detector Advisory Panel for ten years which had 30 lab collaborations involved. Recently for me, DESY has been the major driver in the new standards that we first introduced to the labs in a paper at the 2004 Nuclear Science Symposium in Rome, ATCA, and a workshop on MicroTCA for Physics at Fermilab in 2007, followed by a launch of the Standards Development Committee at IHEP in Beijing in 2009 which I chaired to completion of five published standards for Physics in 2015-16. I get high recognition for this work at DESY but at SLAC was considered a troublemaker despite a very successful demonstration of superior performance on the first LCLS-II Injector and also the recommendation of an external review committee.

ZIERLER: Oh. Interesting.

LARSEN: Project Managers Rule.

ZIERLER: In regard to those partnerships, what was your sense of — what were the kinds of things that could only be done at SLAC, or that SLAC did the best?

LARSEN: For a long time, I think we did electronics in general among the best, because we had Silicon Valley on our doorstep. And we couldn't help but be the best. I mean, you're there. If you see these things firsthand, and you can take advantage of them faster than any others do, then you're going to build something new and different. I think we were leaders for quite a few years.

ZIERLER: And in terms of taking advantage of the fact that Silicon Valley is right there, how does that work on a day-to-day, in terms of — I mean, just physically being so close by? Are people at these firms visiting SLAC? Are you going to them? How is the partnership actually capitalizing on this physical proximity?

LARSEN: As far as my stuff was concerned, it was all service related. We needed new stuff. We knew companies that could do that. We would take the initiative and go to them, get their help with designs, and so on. And a lot of that started with hybrid circuitry, and ended up with real integrated circuits. We also had a critical collaboration with the Center for Integrated Systems at Stanford, Terry Walker designed our chips for us, the ones that we patented. We did several generations of that after four of us from SLAC formed a company (Analytek Ltd). So yeah, lots of interaction. And I can't remember how many different companies we visited in trying to partner with them in some way, but it was a lot.

ZIERLER: Well, Ray, I think I have three big questions to end on this that just — it's just such a great opportunity, so much institutional memory that you have. And the first one is very broadly conceived. From the beginning to retirement and even in your ongoing affiliation and work at SLAC, to what extent has SLAC changed, and to what extent has it remained what it was from the beginning?

LARSEN: The main way it has changed in my experience is — and I think there's a lot of people that would agree with me — is that it went from the "we're all one big team" kind of an operation to a: hey, we've got to watch the budget, you don't just hire an engineer anymore, you hire a project guy. When the project's done, go find yourself some other work or go somewhere else. So, to compare with other labs, which do not operate this way, if you go to DESY, or to GSI, or to others I could name in China or Japan — you're hired. You've got a job. And they will ask you, "What do you want to do? What area interests you the most?" We don't have any of that happening. It's all task specific, charge number specific. It is always a manager's problem to have jobs for his or her people but the higher levels have to provide the budgets to have useful development projects always available for the inevitable gaps between projects.

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ZIERLER: When did that happen? What was that transition?

LARSEN: Relatively recently, well after my involvement with my return from the business world in 1996 to work on PEP II, NLCTA and the LCLS-I Injector project ended. The onus to count every hour against an appropriate project or job charge number, is very recent from maybe 6-8 years ago and I heard recently it's a DOE mandate for all labs. I don't know that firsthand.

ZIERLER: So you see this as a matter of particular leaders. These are not structural issues relating to broader budgets with DOE contracting, or Stanford, or things like that. These are political decisions, you're saying.

LARSEN: Well, it's at least partly if not largely a DOE problem. I think a lot of this high-level pressure comes from DOE. You've got too many layers of management. You've got to change. You've got to compromise. You've got to be more efficient. And I hate to say it, but it's not a place where I would recommend a young Ray Larsen to go to, because it's totally missed out on this family idea. It tries to be one, but it seems kind of phony when you know that jobs are very insecure. People are expendable. There's no long-range loyalty. I hate to say it.

ZIERLER: Is there some point in the future, or a game plan, when you think it could be restored to those days, or do you just think these are — it's just a different world we're living in now, and these issues are bigger than what you've seen at SLAC?

LARSEN: Yeah, it's — I don't know. I keep running into people who think so differently from what I think that it's kind of like I was in a little dream world. And it's not going to just happen.

ZIERLER: Yeah.

LARSEN: Now, if there were — and the other thing is, SLAC has gotten so diversified. It was a single-purpose lab for all those years, and it was during that time — it was a heyday of everything — and now it's so multipurpose, I don't know what the unifying purposes are anymore. They're just all over the map. And so, there's all this — I don't know. It's a lot of — it's just a harder place to work at, to understand, and to relate to. I mean, there are parts there that — I don't know a single soul in the Astrophysics Division, for example. It's a huge piece of stuff activity, but you would think — maybe I'm just missing it, but you would think there would be an effort to share all of these -- the new technology that's happening every day, and new macro discoveries relating to the micro, I think it's fantastic, but you never hear anybody talking about it to the lay people. And you know, so I'm like, hey, there's this general interest meeting that we can have covering all of these fields and educate people on what's happening within the lab and give them all a sense of ownership.

ZIERLER: My next question, to go back to this concept of the heyday — and it might be one moment, or it might be many moments, but I want to ask you: what sticks out in your memory as your proudest moments, your most impactful moments, your greatest contribution? Are there many? Do you see that as a particular project? Is it a particular collaboration? What are the things that really jump out from all of your years there that make you most proud?

LARSEN: I'm not a person that likes to brag about anything, so I'm a little reserved when I answer a question like that. In one sense, I'm proud of every bit of it. It's a remarkable privilege that I've had, most of my life. It's just incredible. I can't nitpick about that. It's just the way it is. I couldn't. SLAC has been a tremendous employer for so many years. I'm close to the oldest guy there, I think. And if I stop falling down and wrecking my joints, I may last until [laughs] I'm the oldest one. At the same time, there are moments, I suppose, I think — here's one thing that makes me proud, and I never talk about it. But Marty Breidenbach has always been a great friend, and we worked together many years. And he's quite a bit younger than I am, but he was always energetic and a hard driver, a bit excitable. He's much mellower now that he's sort of retired. [laughs] I don't know if he's really retired or not. But anyway, he and I got along wonderfully well, and he was a guy that always was interested in the next thing, the cutting edge. And he would come and say, you know, "We've got this problem. Can't we do this — can't we solve this somehow? How would you do this?" And he'd come to me to explore his needs and ideas in new electronics, but he also came to me because he knew our team could get things done. Of course that was our job, and his work was always exciting. So, one of my proudest moments was just hearing him tell somebody — I think he wrote it down — was that "Ray has the gift of getting world-class work out of non-world-class people."

ZIERLER: [laughs] That's great.

LARSEN: And it was kind of a dig, maybe, at some of the people I supervised, but I took it as a great compliment to the people. But I also think that if you have to tell *yourself* all the time that you're world-class, you're not world-class.

ZIERLER: Yeah.

LARSEN: But don't give me that world class stuff. It's just not important to go around bragging in this way, and certain people do this. I mean, some directors did this, "Well, we're world-class." I'm saying, "Ah, give me a break. [laughs] You're not world-class. You wouldn't have to talk about it if you were world-class. But I have to confess I hugely appreciated Marty's compliment to my team who did all the real work.

ZIERLER: Yeah.

LARSEN: I was certainly — it's not that I'm super duper dwelling on myself. I try not to do that. That's a bad habit. But I was very proud of the first time the SLAC beam got turned on. We were all there, a rather small group actually, late at night in the Control Room when the first accelerator beam got turned on all the way to the End Station and I saw all my beam position and charge monitoring stuff on the screen, and everybody ooh-ing and ahh-ing about it.

ZIERLER: Was it a dramatic moment? Was there any concern that maybe the beam wouldn't turn on?

LARSEN: No, no, no. They knew it would turn on. This was just the time they finally got every last piece into it, and then steered the beam into the End Station and actually could see it on a screen in front of a target. That was the dramatic moment. That all happened in one night. And it was a privilege to be there for that. It was great. And what other — I can think of a lot of people I really admired, and Burt and Pief were at the top of the list.

Another thing was I was just getting to know Pief and his passion about arms control, along with Sid Drell, and I was pretty much involved in some of that myself. Not at the level they were, but just in the level of promoting the understanding and the need for it. And I had both Pief and Teller give talks to our IEEE Chapter ___ group about arms control. When Pief gave his talk, that's the first time I learned that there was *one ton* — and this was many years ago, right — *one ton of TNT equivalent for every human inhabitant* in the arsenals of the U.S. and the U.S.S.R. And that's a stunner. Why do we need a ton equivalent for every single one of us? And the answer is: you don't. And even today, people who have time to stop and worry about it are worried that there's some crazy bastard that's going to push that button.

ZIERLER: And the irony there, of course, is that there's a very fine line between the fact of all of these arms and who created them.

LARSEN: Yes.

ZIERLER: Right?

LARSEN: Yes, indeed. Yes, indeed. Anyway, those are the — you know, I'm at a point in life where I'm trying to put things in a lot of perspective. Working with some of the poorest people in the world puts it in perspective, because it brings up why we are where we are, and why we behave the way we behave, and all that went before us that made us the greatest nation in the world, and what price other people paid for that. That troubles me.

ZIERLER: Yeah.

LARSEN: And I thought in the slave movement that started it, 400 or 500 years ago, I thought: well, my ancestors weren't involved with that, were they? I was wrong. Sweden had a big slave fort on the Ghana coast, along with the famous Coast Castle that the British had, which we visited during one of our workshops there a couple years ago. And some of the guys who went on the tour to visit the Castle thought, "Gee, we're going to see a nice castle." You know? "Some Royalty and riches; and what we saw was a hellhole of how they stacked the prisoner slaves in dungeons for up to 2-3 months, dirt floors, total darkness, no water or food or toilet, 1500 at a time, before they threw them onto the offshore ships for an equally hellish voyage of 1-2 months to the Americas. And a million of them just died right there in that '"castle" that we visited and on the ships. In the upper levels of the Castle where the captors lived life was perfectly normal and many oblivious of what was underfoot. What kind of people are we that could do this?

ZIERLER: And even if there wasn't that particular national connection in your past, there's a bigger perspective that doesn't relieve anybody from collective responsibility.

LARSEN: Yeah. Exactly. Exactly. And it's true today. We're fighting it every day. You know? It's like, nobody learns anything.

ZIERLER: Yeah.

LARSEN: We've got this unmentionable person who's leading the pack in just being so incredibly ignorant and insensitive that you lose all hope. You tend to lose all hope. That's not good.

ZIERLER: Well, Ray, for my last question, you've already made your views clear about the future of SLAC, and so I wonder then if I'd reformulate — you know, it sounds to me like what SLAC might need is sort of a back-to-basics kind of program. Right? Obviously, that's a tall order in terms of the way that SLAC has changed structurally, and it would be fanciful to sort of assume that a back-to-basics program could or would be fully implemented. But let's say, just going small, that part of it might be. You know? If there was something about what SLAC used to stand for that could be reignited — small scale? Right? I mean, again, realistically. In all your years at SLAC, and all your experiences with the different directors and the projects, what would you emphasize in this back-to-basics report? What is the thing that is most important that SLAC remembers about itself, to ensure its success in the future?

LARSEN: SLAC was a brand-new laboratory and single-mission laboratory, it was unique. You know? That was a great advantage. And that largely explains the — it was a tight-knit team. It wasn't so big. It actually got pretty big. It got almost as big as it now, but it was — a single mission that made it unique. And, "How do we get back to having a single mission?" is kind of the question you're asking.

ZIERLER: Right.

LARSEN: And if I were in charge, I would say you've got a tremendous opportunity to do that, because we are exploring the entire universe, for God's sakes, up and down. And I don't know if any other labs are doing that as we are, and I don't really care. I don't care whoever isn't doing it. But people need to understand: this is a universal kind of an enterprise that we're on, and everything we're doing is somehow contributing to it. And if we can just articulate that to ourselves, to the whole group — and if we can put some — I don't know — some more kind of idealism into our people that will make them just love the place, like we originally did, I think it's possible. And I think it takes a unique leadership to do it, and I don't see it happening. But it could happen.

ZIERLER: So, it's possible if given the right set of circumstances. You're not advocating an impossible game plan here.

LARSEN: No. No, I don't think so. I'm advocating for leadership, and how they treat people, and how they — you know, if you take the time to explain things to everybody, you're respecting them. You're teaching them. You're bringing them up. Why aren't we doing that for every single person at the laboratory, instead of making them all feel threatened about their jobs? And if they don't get a charge number for the next job, they don't get paid. Or they're out the door. That's the way it is right now.

ZIERLER: Yeah. Have you ever availed yourself of the opportunity to share these perspectives with people in a position to act on them?

LARSEN: I got the distinct impression — I tried, actually, to connect with one of them who was there for a while, a new AD, and I tried to avail myself to have a discussion about the state of engineering and the impressions of people I work with, because there was so much unhappiness among them, for very good reasons. And I never got a phone call or Email back. I mean, there was no interest. And I think there are some — one or two people in the hierarchy who, if they had heard this person wanted to talk to me, would probably have said, "Don't," you know, "because I don't like that guy."

ZIERLER: Well, Ray, I mean, one of the things that's been — there's been so many things that have been special about our discussion today, and one of them, I think, is that it's important that history and personal recollections is not all just sugar-coated, that you bring a tremendous amount of conviction and authority to your opinions. That's obvious. And I think that many of the people who could, and should, listen to this oral history are not going to take your…

LARSEN: Yeah.

ZIERLER: …views lightly. And so, in that regard, I think that your perspective offers a tremendous service, because I think it's very important that a number of people understand that the things that you're saying are not impossible to implement, and in fact, the stakes are quite high for them to be implemented. I think it's a tremendously valuable, and a tremendously important, perspective to have. And I want to thank you for sharing that with me.

LARSEN: Well, thank you for the opportunity. I hope someone besides you and I may agree!

ZIERLER: Well, stay tuned for that.

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