Deken [00:00:01] This is Jean Deken, I'm going to be interviewing Les Cottrell of the office of the CIO, and Randy Melen, Deputy CIO is going to be assisting in the interview... [pause and restart] So I guess, if we could just start, Les, with you talking about your background, and what you did before you came to SLAC.

Cottrell [00:00:22] Oh, okay. I'm from England, and I did my Bachelor of Science and PhD at Manchester University. The PhD was in nuclear science. I got my degree in two thousand, oh, I'm sorry, 19...1967 on the 20 -- gosh, I've forgot the date now --I think it was the 23rd of July.

Deken [00:00:56] Oh, in July?

Cottrell [00:00:56] Yeah, that's right. Yeah: and on the 24th of July we got married. I should remember that date because that's my anniversary [laughs]. And then we went off on honeymoon, we camped in Cornwall, and then we came to the US, landed in New York and I think... And then we flew on to, let's see, Montreal for the World Fair, and then we tried to come back, and we actually had the paperwork for a green card, but we'd handed that in at New York, so we tried to come back in at Detroit, they gave us a hard time, we almost missed our flight, you know, to fly from there to here. So that was a little bit worrisome. And then we got here, I think about... I think it must have been about August the 6th, but I'm not sure...

Melen [00:01:53] What was your thesis topic?

Cottrell [00:01:55] Thesis topic was...um, what was it now? Ah, ho... It was on Carbon 13, it was ah ... Stripping reactions in Carbon 13 and the optical model. I don't remember the exact title. I have the thesis upstairs somewhere buried in a load of other stuff. It took me five years to get it. Eventually I figured I had to get out: I was having more fun ‘cause I did a lot of programing on fitting the data, too, and so I got involved in computer programing...

Melen [00:02:30] This was at the University of Manchester?

Cottrell [00:02:30] The University of Manchester. They had a supercomputer there then called Atlas, that was one of the first big supercomputers they got...

Melen [00:02:42] This is one that they built themselves...

Cottrell [00:02:43] It was one they built themselves, with the help of Ferranti...

Melen [00:02:47] Ferranti Packard ? or just Ferranti?

Cottrell [00:02:47] I think it was just Ferranti at the time.

Melen [00:02:51] It was one of the major British computer manufacturers. [https://en.wikipedia.org/wiki/Atlas_(computer) for a reference]

Deken [00:02:57] Oh, okay.

Cottrell [00:02:57] So, prior to that I'd written to various places: I wrote to CERN, I wrote to Rolls-Royce, I wrote to various other companies, and had several offers. I actually accepted the one at CERN, but then I got an offer from here, and I'd been to the US

before, a couple of times, and everyone here said, 'you have to see the West Coast.' So I thought, 'Oh, I'll come here for two years and see the West Coast, and I'll have been at a decent place, so I can get a decent job somewhere else.' So, I came here for two years, and that prediction was a little bit off [laughs].

Deken [00:03:31] [Laughs].

Cottrell [00:03:31] So I stayed a while. So yeah. So, we got here, and I joined Dick Taylor's group, which was the inelastic...oh, it was End Station A experiments which started out with elastic experiments, elastic electron experiments bouncing off of protons and then went on to do inelastic electron scattering that was expected to be not particularly exciting: they expected to see some resonances and other stuff like that. It was a collaboration between MIT and SLAC, and so there were two professors from MIT, there was, gosh, oh, Henry Kendall... And who was the other guy....

Deken [00:04:22] Friedman, Jerry Friedman.

Cottrell [00:04:26] Friedman, that's right, Jerry Friedman. So, we did the experiment, had lots of students, Marty Breidenbach was one of the students at the time. He was... He was getting his Ph.D. and Eric Green had just joined... He joined, kind of like, a few weeks before I did. So, he was... He was... He was good at helping to get around and … and there were… other, there were other people, there was another English guy called John Litt who was in the group.

Deken [00:04:48] John?

Cottrell [00:04:50] Litt: L-i-t-t. He went back to Rutherford Lab eventually. So, initially I was working on the electronics... Trying to automate setting up the electronics. One of the big problems with that was tuning the photomultiplier tubes to have the right voltage, to get the optimum collection of data. And so, what you do is you ramp up the voltage and then you ramp it down and you can see where, where you get the plateau, which gives you the best performance. And Henry Kendall, who had designed this very complex system, which was computer "talkable-to /controllable-from," had set up the system, but no one had ever programed it. So I programmed it. It didn't work very well: the components of the system kept breaking down, so there was an enormous amount of problems getting it working. We used it in a couple of experiments, but in general we tended to do it by hand eventually. But then, eventually, Richter and Taylor got together, and made them do an experiment to actually calibrate the magnets in the spectrometers, so they would know exactly what they were set at. You know, a given character of the magnet would be your current, a given field, which would therefore give you a given bending radius and therefore you would be able to tell what the energy of the particle that you were seeing was. And, at this time, Dick was short on people, and he said, 'OK, you can come and help us down here,' so I got to work on experiments at this...you know, work on real...on the real-time side of things. After that, I spent an enormous amount of my time down in the End Station A, in the control room and...

Melen [00:06:36] Were you there when...before End Station A was constructed?

Cottrell [00:06:37] No, End Station A was complete by the time I got here, the experimental halls were both complete, the Beam Switchyard was complete, in fact I think they were completed in late 19...1970.... 1966. And so a lot of the elastic experiments had been done. And so we knew the results from the elastic scattering of electrons onto

protons. So, we were able to use that to calibrate other things because we knew exactly where the peak should be, 'cause you can calculate that from kinematics. So, then we went on to the inelastic scattering. Now, when they were doing the elastic scattering, they were involved with Caltech, Barry Barish was one of the leaders. And there was another person who was... There were two people from there, and they had a group of students from Caltech, which is always a lot of fun. This was about the same time...In the previous year, there'd been a group from UIUC who had been led by a guy called Brown, I've forgotten his first name, anyhow, so he led the group, he was a professor there. And they had come up with this scheme for making the controlling and gathering the data from the spectrometer using what was then an SDS9300 computer, which had a very nice full-track compiler.

Melen [00:08:01] This was Scientific Data Systems, before Xerox bought them...

Cottrell [00:08:02] That's right, yeah. And they became Xerox later on. And, so some of those students were still around. The person who developed it had actually left by this time. And eventually it was canned and not used, because it was taking too much memory. We only had 32...kilobytes...no, kilo-words: a word was three bytes to a word, 24-bit words on the machine. So that system was canned, and Adam Boyarski pretty much put together a system which was really the basis for the system that we used ever after that. I made lots of enhancements to it and, you know, got into the system. And Tony Gromme basically rewrote the operating system. Tony Gromme was a ...um... He was a full time... What we would call a computer research person, worked for...oh, who was the guy who was in charge of computer research?

Melen [00:09:04] Jerry Friedman.

Deken [00:09:04] And it was, ah...I've got it here in my notes. Before Jerry it was... ah ... Bill...

Cottrell [00:09:07] Bill, that's right....

Deken [00:09:07] Bill...

Cottrell [00:09:11] That's right: He went to...he went to SRI after that, and it was not why...

Deken [00:09:20] I know it's here...Miller: Bill Miller!

Cottrell [00:09:20] Yes, yes. Bill Miller did it. Yes. So, he'd been hired by Bill Miller, and he was just brilliant. He took a year...

Deken [00:09:38] Tony Gromme?

Cottrell [00:09:38] Tony Gromme: G-r-o-m-m-e. He made a brand-new operating system.

Melen [00:09:45] For the SDS machine?

Cottrell [00:09:45] For the SDS machine. And it was way better than the old one. They made one minor modification to the hardware. There was a problem with the old SDS machine because you could have reentrant code because... When data needed to be read, you'd get an interrupt. Which would then stop everything that you were doing, and you would then enter a different subroutine. And so, you had to save all the history of what

you were doing, so when that program came in "FINISHED," it would restore the previous one.

Melen [00:10:15] Reentrant code has to be written so that it's not self-modifying, yes. Exactly the way Les is explaining it. I don't know if anybody even talks about reentrant code anymore these days.

Cottrell [00:10:27] I don't think so. So, anyhow, he wrote the system and in the previous system it was very, very complicated. So, Tony requested that one minor modification made to be... Made to the system such that…

Melen [00:10:39] To the hardware?

Cottrell [00:10:40] To the hardware.

Melen [00:10:41] Yeah.

Cottrell [00:10:42] So that when the interrupt came in, you had one instruction during which you could do something, and all you did was you disabled interrupts for that one instruction. So… no other interrupts could come in, so you couldn't get an interrupt on top of an interrupt.

Deken [00:10:56] Oh...

Cottrell [00:10:56] You could actually, you know, save everything, and then re-enable the interrupts, and that simplified the operating system enormously. And also, he improved the FORTRAN compiler, which at that date was way better than any other compiler on the market. There was, IBM had compilers, [BOSE?] had compilers, CDC had compilers, and this was, without doubt, way out the best FORTRAN compiler that existed at the time. And it was written for...he didn't write the compiler, but he modified the compiler to add a lot of extra new features. And he used his better [reactioncy?] See, he spent a year during which he was kind of sequestered in an office with a pencil and paper and cards and just rewrote the operating system. And it was a brilliant operating system. And not only did he do that, but, as I said, they were limited to 32000 words, but he made it so that you could have ... Um...what's the word? Ah, when you can...have partition... you can bring in other... what's the word when you bring in...

Melen [00:12:06] Swapping?

Cottrell [00:12:08] It wasn't quite swapping. It's a better layer than swapping.

Melen [00:12:11] Paging?

Cottrell [00:12:11] It was basically paging, except it was quite as good as paging: but it was equivalent to paging.

Deken [00:12:17] Sort of a precursor of paging?

Cottrell [00:12:18] Yeah, yeah. And so… you could actually...so we would then extend the size of the programs. So, if they were laid out, they wouldn't have to fit in the 32 kilobytes... Kilowords. But if, if, if they were all laid out and all present simultaneously it would have been 130 kilowords. So, it really enabled us to do a lot more with the machine, it really kind

of gave a long life to the machine. So, he did that, and we took advantage of it, of course. And then, of course, you know, at the same time, the, we had the 360 91 coming in here, and the 360 91 replaced, I believe, a 360 75, but I couldn't be 100 percent sure of that.

Deken [00:13:08] 360 75?

Cottrell [00:13:09] 75. Which was an interim machine, while they were trying to get the 360 91 delivered. And that was agreed to. I think originally, we had a 360 50, but then they were delayed on delivering the 360 91, they brought in the 360 75 and then we upgrade to the 360 91. So, then I got involved in the offline stuff, which was all written in IBM's FORTRAN. They had two FORTRAN compilers: FORTRAN G and FORTRAN H. FORTRAN G was written by your alma mater [indicating Randy Melen], otherwise known as Waterloo. [Note from R. Melen: No, Fortran G was an IBM compiler product. Les' referral to Waterloo is to the Watfor and WatFIV Fortran compilers, really interpreters, used for fast compiling for student instruction of Fortran. Unlikely these would be of any real use at SLAC.]

Deken [00:13:45] FORTRAN G, yeah?

Cottrell [00:13:45] Yeah. And FORTRAN H was a very powerful...

Melen [00:13:48] Very optimizing...

Cottrell [00:13:49] Optimizing compiler, but it wasn't as friendly as yours...

Melen [00:13:53] Do you know what FORTRAN H was written in?

Cottrell [00:13:55] FORTRAN H.

Melen [00:13:55] That's right. [Both laugh]

Cottrell [00:13:56] Which was a brilliant idea and it meant that it tested itself. So they wrote that compiler...

Melen [00:14:02] It made some interesting bootstrapping problems to get started, but, yes.

Cottrell [00:14:04] Yeah. So, they were late in getting to market with this... which is why they introduced the, provided the FORTRAN G compiler to get started. So, so we then had to take the programs online and convert to offline, which meant converting them from one FORTRAN compiler to another. Of course, we didn't need all the [reentry C?] and stuff like that, so that didn't hurt. And we had a lot more memory on the... ah... I think we had two megabytes of memory on the 360 91 at the time.

Melen [00:14:43] And I think the 75 was limited to one megabyte.

Cottrell [00:14:45] I think you're right. Yes. So, we rewrote that, and then we also, about that time, started to introduce WYLBUR, which was a very nice text editor. And at that time. this was about 71-72, I decided to introduce these 2741's, which were basically IBM Selectric terminals, which had been modified to have a connection to the mainframe. Prior to this, most of the input had been done by cards, and then at this stage we were able to enter data to the mainframe via… via typing at the keyboard. At the time we probably had

about 20 to 30 keyboards, which were heavily sought, and so that a committee was set up whose main purpose was to allocate who gets a 2741. I mean...

Melen [00:15:38] Was there a public terminal room as well?

Cottrell [00:15:38] There were always public terminal rooms: there were no private terminals. So… at that time, because, with that many, you couldn't afford, you know, any individual to have one. So, it was the...Everyone was scrambling: Group A, Group B, Group C, the Computer Center itself. They all wanted terminals and you...

Deken [00:15:55] Were they all... were all the 2741's in this building [Building 50]?...

Cottrell [00:15:56] No, no. Eventually we managed to get them delivered to other buildings, so there were some in ...eh...um… let's see...building...the Central Lab Annex, and building Central Lab, you know, for the first and second floors, there'd be a couple in there, and you'd always be scrambling to get there... I don't think we... I think some people had sign-up sheets, you know, to... to get on. If you didn't use the terminal, you could obviously use punch cards, but it was not as good. As time went on, another thing happened with it, ah... Dave Gustavson, who went to work for...who left SLAC several years ago and went to...

Melen [00:16:45] He got a faculty position at the ~~Center for~~ Computer Engineering Department at [Santa Clara] University, forming SCIzzL, and then he retired. [for reference: https://www.computer.org/profiles/david-gustavson]

Cottrell [00:16:46] at [unintelligible] University, yes.

Melen [00:16:46] He comes around every once and a while: we still see him.

Cottrell [00:16:48] He wrote a simulator, which enables you to run on the IBM 360-91 and simulate being on a 9300, so that meant we can write...

Melen [00:17:02] On a 9300?

Cottrell [00:17:02] An SDS 9300. [reference: https://en.wikipedia.org/wiki/SDS_9_Series]

Melen [00:17:04] Oh!

Cottrell [00:17:05] It's a simulator for an SDS 9300, so we were able to use the editor to develop the code, then put the code into the simulator and check out that it was going to compile, etcetera, on the simulator before we got down to the real SDS 9300.

Melen [00:17:23] We should have Dave come some time and be interviewed about things that he....

Deken [00:17:26] Yeah.

Cottrell [00:17:26] Yeah. Mention that one too. And that was a big advantage because there was only one SDS 9300, and of course, it would be running the previous experiment, so you couldn't get on to it until like three or four weeks before YOUR experiment had to go, so it was always a mad rush to get the code working and debugged and everything else. So, this gave us a little bit more flexibility in developing the code. And another thing

which we used the simulator for was, they had this wonderful "wireless program." And the wireless program kept track of where all the cables ran and...

Melen [00:17:59] And when you say the "the wireless program" what do you mean?

Cottrell [00:18:00] It was basically a cables program; it would tell you...

Melen [00:18:04] It man dated… it...

Cottrell [00:18:04] It kept track ... it was a database that kept track...

Melen [00:18:10] ...it was an inventory, basically, of...

Cottrell [00:18:10] ...of all the cables...

Melen [00:18:10] ...of your cabling and wiring, as opposed to what the word "wireless" means nowadays.

Cottrell [00:18:10] Yeah... Oh, I'm sorry. It was called "wireless" but... It was called "Wires."

Deken [00:18:18] It was called "Wires?"

Cottrell [00:18:20] I don't know what it was called. Maybe... It wasn't called "Wireless", yeah, I got the wrong name, thank you for correcting that one, yeah. So...

Deken [00:18:21] So it was an inventory of the cables...?

Cottrell [00:18:21] Of all the cables which were in End Station A...

Deken [00:18:21] Was that CAPTAR?

Cottrell [00:18:21] No, no, it was way before CAPTAR got developed...

Melen [00:18:25] I think it became CAPTAR, though.

Cottrell [00:18:36] Yeah. It was developed by a student, originally, and then he left, and a guy called Ken Johnson used to manage it and it ran on the 9300. We did try... Oh, and then we...so, we tried converting it to run on the IBM, ‘cause it was written in FORTRAN. And it was just a nightmare, because the sorting order between ASCII code and EBCDIC code was a night...was not, was not the same. Of course, it was doing a lot of sorting...

Melen [00:19:00] EBCDIC is E-B-C-D-I-C.

Cottrell [00:19:07] Yeah, that was IBM's internal code for representing...

Melen [00:19:10] Extended Binary Code Decimal...

Cottrell [00:19:13] Interchange Code.

Deken [00:19:17] Okay.

Cottrell [00:19:18] So we never got that to work, but once that Dave Gustavson's simulator came, we just… We just ran it off the simulator.

Melen [00:19:27] Off the simulator...

Cottrell [00:19:28] And so Ken, Ken Johnson was able to do all his work on the IBM 91, didn't have to go down to the SDS 9300. And the equipment [facilities?] group extended its use to other uses besides what we were doing in End Station A.

Deken [00:19:40] Hmmm...

Cottrell [00:19:42] Another thing which we got for the students in End Station A on the 9300 is "Space War," which...

Deken [00:19:50] I've heard of it, yes...

Cottrell [00:19:50] Originally, you used the keyboard to move things, but of course... And then you used their control panel, which had lots of switches, you know, for turning on histograms, and things like that. And then we used that, and then...then we got some joysticks which came from the Bubble Chamber scanning people: we were able to move it forwards and backwards and click and shoot and go into hyperspace. So whenever...whenever things...There was never much time to play, we were always too busy, but if ever things got really quiet, like the experiment was running fine, but the beam was down, and you knew it was going to be down for six hours, you'd bring up Space Wars (laughs)...

Deken [00:20:30] (laughs).

Cottrell [00:20:30] And, you know, while the night away. So, that was another thing which came out of the students who were down there.

Deken [00:20:34] When you were playing Space Wars, were you playing against yourself? Or were you playing with each other?

Cottrell [00:20:39] You play…two teams are playing… or two people play. So, you could fire at the other team, you turn on gravity or leave it off, you know, there's a lot of things like that. And you could go into hyperspace, in which there became a decreasing reliability you would ever return from hyperspace. (Laughs) So it was kind of a last-ditch effort, if you see he was about to shoot you down, hyperspace and hope you come out. And then that game, I guess, got...went further, because they had those machines in bars and things like that that actually did it. It was one of the early computer games that made it into the industry. Okay, so... so... We did lots of experiments down there, and there was a lot of interest because at that... The big scattering cross-section was very different from what was predicted. And the reason...What was happening was, more particles were being scattered and coming back, so to speak, were being scattered backwards, or into a large angle. So we expected they would just be...you know, go into the cloud of whatever it was, you know, between the... in the proton, and then be slightly deflected. Some of them were coming way back, and so people got very interested in this. People like Bjorken... and there was a guy...a guy… I can't remember the name...

Deken [00:22:08] Feynman?

Cottrell [00:22:09] No, no. Feynman came... he came along, but before him, there was another person who was very interested in this...

Deken [00:22:18] A theorist?

Cottrell [00:22:19] A theorist. And they would come down at night, and, you know, would sit around saying 'what are the results showing you?' You know? And we would say, you know, 'this is the results rough, you can't publish them yet,' you know, 'but they are coming back as this… it's more than what you'd expect now off-hand. Now, maybe, we may have a bug in the machine, and it may be bad in the code, maybe our solid angle measurements are wrong, who knows what it is..." And Pief would come down... I mean, you know. Pief was quite amazing because, you know, he'd work a day in his office, then in the evening he would often be down there, sitting, talking with Dick Taylor or with the rest of us seeing, 'how are you doing? how are you getting along?' I think in a large extent Pief mentored Dick Taylor...

Melen [00:23:03] Really?

Cottrell [00:23:03] And you know, so... And Dick was in... was the SLAC person who was in charge of the experiment...

Deken [00:23:08] Right.

Cottrell [00:23:08] And so he [Pief] began and chatting away, and telling, you know, and finding out what was going on, and then next day he'd come back and do his job at the lab, you know. So, they were very exciting times. And then other experiments came along where they got more and more complex: you'd wind up with a target which was polarized, so the protons in the target would have a particular spin, and we would change the spin on the target, we would see what the effect was, and then you would get the effects of spin on things. And then we had... we would get the electrons, which were coming down the pipe, would be polarized, and that would be... So… the polarized beam experiments were done with LBL, and Owen Chamberlain, who was another Nobel Prize winner, was one of the people....

Deken [00:23:58] What was that name?

Cottrell [00:23:58] Owen Chamberlain.

Deken [00:23:58] Owen Chamberlain.

Cottrell [00:23:58] And he was the leader of the Berkeley team. There were some students in there, Steve Rock was one, who later on became part of SLAC, was on the experiments there. Chuck Moorhouse, who went to work at HP, is another one, and they would be programing the PP8s or whatever... I think was PP8s that were monitoring the target and keeping the target. It had a very good...the person that built the targets, Michel Borghini, and he was from France, actually he was from Monaco...

Melen [00:24:29] From where now?

Cottrell [00:24:29] Monaco. And it was funny: I ran into him at a meeting, it must be about five years ago. I didn't recognize him, and he was very smartly dressed in a suit and everything. And it was at a...it wasn't United Nations' sponsored, it was an IT [?] I think,

in Geneva, and he came up and he says, 'hey, Les' and I said 'hey, good to see you again.' I didn't know who… who the hell he was, you know. (Laughs).

Deken [00:24:57] (Laughs).

Cottrell [00:24:57] And so he said, 'I'm Michel Borghini.' 'Oh, Michel, how are you doing?' And he was an ambassador...

Deken [00:25:05] Oh, for goodness' sake!

Cottrell [00:25:05] ...to Monaco at the time. (laughs).

Melen [00:25:10] Wow: that is wild!

Cottrell [00:25:10] So I was while he was the designer of the target for Owen Chamberlain's group. And then after that, the people who did the electron polarized beam was a guy called Vernon Hughes...

Deken [00:25:23] Oh, sure.

Cottrell [00:25:23] And his son works at SLAC still.

Deken [00:25:29] Mm-hmm.

Cottrell [00:25:29] Vernon died a few years ago, actually, so did Owen Chamberlain, he died a few years ago. So, their team came in, and we were working with them, and other people joined. So, they didn't ...(whistles) ...Let's see...19... Oh, in 1972, I took a year off... And went to CERN and was working on an experiment there called the 'split field magnet.' I went there with the idea I'd work on the real-time, but ... Ah...it didn't work out too well. So, I joined the offline group there, which was actually a lot more organized. The real-time wasn't... I know it wasn't disorganized, it just... It just seemed like I was on the periphery and not able to do much, you know. So, I decided I'd join the real-time group, and the person who kind of invited me was a guy called Adolf Minton, who was a CERN physicist, but when he came to SLAC, he was from Aachen, I think...

Deken [00:26:25] Oh, from Aachen?

Cottrell [00:26:25] ...And so, we had this relationship with Aachen that different professors would come in from Aachen, and so when I got here, Adolph had been here a year, doing his year leave of absence from Aachen here, and so he was...he indoctrinated me when I got here, you know, that what had to be done and things to do and everything like that. So, anyhow, that was in 67, in 72, he invited me to come to CERN, and I spent a year at CERN in his group, working on the split-field magnet. Then in 1980, I'd been... I'd talked to another guy who was at SLAC, working for IBM at the time. David Yount's group has something… an IBM 1800, which was used for real-time data acquisition of the spark chamber data that he was taking. And the person... They had a team from IBM who were working to help him make sure to interface it to the 360 91, and after that the TriPlex. And one of the guys on that team was a guy called Mike Bannister [Bemiston?], who had been a physicist working at Argonne National Laboratories, and then had joined IBM, and so was then working at SLAC for IBM. Anyhow, he had got me in contact with some people at IBM, and they invited me to come to Hursley in England, which is where they have their... um... their lab, the UK labs are. And so, I spent a year in England working mainly on

graphical... graphical front ends. Actually, it was a microprocessor, a Motorola ...8600, I think it was...

Melen [00:28:14] Not the 60...not the 6800?

Cottrell [00:28:15] No, not the 68…right. Not, not the big...Not 86.

Deken [00:28:15] This, this was a Motorola ...?

Cottrell [00:28:16] A 6800, that's right.

Melen [00:28:22] A 6800.

Cottrell [00:28:23] [together with Melen] Later became the 68000.

Cottrell [00:28:23] Because it had ...what they'd done was they'd taken a 3278 terminal.

Melen [00:28:26] Yes.

Cottrell [00:28:26] ...and replaced the guts of it with a 6800. I think it actually already had a 6800 in it, but you couldn't touch it, you know: it came delivered.

Melen [00:28:37] Right.

Cottrell [00:28:37] So working with IBM, they'd got the capability to modify their 6800, and so its paging store was over the [co-ax link?]. They went to the mainframe, and so, they had a paging store...store there and then they had code in the 6800 itself, which ran the program in a language called... PL68, that was it, which was a high-level PL1-like language...

Melen [00:29:05] Well, PL1 came out of that lab, and it was originally called NPL, as I recall...

Cottrell [00:29:05] It might have been. It came out of that lab, and the guy who developed it for that lab had developed PL68, very nice guy. We got on well, he...

Melen [00:29:18] Only computer language I know that had sterling constants.

Cottrell [00:29:22] [Laughs] Yup. Yeah.

Deken [00:29:23] What do you mean by "Sterling Constants?"

Melen [00:29:24] I mean, pounds, shillings, and pence, etcetera.

Deken [00:29:25] Oh, okay. [general laughter]

Melen [00:29:25] It was the data types... but then it made the correct conversions...

Deken [00:29:32] OK.

Melen [00:29:32] You could do arithmetic: sterling arithmetic.

Cottrell [00:29:35] So... So… I went there and I worked on this graphics thing, and it was, yeah, it was the 6800. It was called... I can't remember...actually, I've forgotten what it was called... Oh, I can dig it out what it was called, anyhow. And it was at the time before the PC existed, so IBM at that time were trying to figure out do 'what are we going to do...'

Deken [00:29:52] This was 1980?

Cottrell [00:29:53] This was 1980.

Melen [00:29:55] Oh, it was? OK.

Cottrell [00:29:55] Yeah.

Melen [00:29:56] So it was just getting close to...

Cottrell [00:29:57] Right!

Melen [00:29:57] Because 1981 was when the PC was announced...

Cottrell [00:30:01] That's right, and at IBM... there were lots of projects within IBM computing for what the next generation would...

Melen [00:30:08] I heard there were like gonna be, like, nine or ten projects all vying to be "the" next ...

Cottrell [00:30:08] ...the next generation. And this...ours was one of them, and ours didn't get accepted [laughs]. It was the one from Boca Raton that got accepted...

Melen [00:30:19] There were folks at Waterloo building a competitor...

Cottrell [00:30:19] Oh, okay.

Melen [00:30:19] ...with the Motorola 6809.

Cottrell [00:30:19] Oh, okay.

Melen [00:30:19] And there was ...There was a bunch of folks at IBM who did... remember Word processors?

Deken [00:30:29] Oh, sure: Wang and...

Cottrell [00:30:29] Yep, yep.

Melen [00:30:29] That's right. IBM had us download a word processor that they were trying to convert into a competitor of the personal computers...

Cottrell [00:30:37] Oh, okay. So, there was a lot of stuff going on and there was a lot of talking between the labs, and everything like this. Anyhow, and so I spent a year doing that. Then I came...Then the job of head of networking became available and SLAC posted it, and somehow, I heard of it and I thought, 'that sounds like fun.' By this time, I was thinking ‘I don't want to run anymore shifts in the middle of the night,’ … 'cause... I mean, A was a small group, we had about 10 of them, and 12 people. I needed

twelve...three people on shift: one to run the electronics, one to do the computing, and one to do the physics. So, you had few people on a shift. So, with twelve people you were running, you know, for several months, and you didn't really get any time off, not even weekends, and it was awful. And I said, 'I'm fed up with this,' [laughs] so I want out, and this was a way to get out, so I applied for the.... [recording stops]

Cottrell [00:00:11] So I arranged with IBM Hursley for me to visit the IBM Research Center on Hanover Street in Palo Alto not far from SLAC and while on the visit interviewed with Chuck Dickens and Joe Wells of SLAC.

Melen [00:00:23] Oh yeah.

Cottrell [00:00:23] And Chuck was very, very enthusiastic. and Joe didn't seem very enthusiastic. Joe was more the techie.

Melen [00:00:33] Yes.

Cottrell [00:00:34] Joe was asking me technical details on networking ... luckily, at IBM Hursley I'd done a course on SNA, IBM's Systems Network Architecture. Thus, I had a pretty good idea about networking IBM mainframes, even though I had not actually written any code using it.

In addition, before I had left SLAC for IBM, I had actually worked on a DECnet asynchronous interface for a DEC LSI 11 and with it simulated a person at an IBM 2741 terminal talking to the IBM mainframe text editor (Wylbur) automatically logging in together with a password and communicating. In this way we could upload the data that the LSI-11 had recorded in a test lab. Thus, we no longer had to rely on the LSI-11 having a tape drive and then manually transferring the data by tape from the LSI-11 to the IBM mainframe.
It was great for testing purposes. You could also download software, so we could keep our software in one place. We also had a PDP-11 simulator from John Stephanie of the Computer Research group, that ran on the IBM mainframe. Using the simulator, we could boot up the PDP-11 RT-11 operating system on the IBM mainframe and test our programs without ever touching a real PDP-11. One interesting feature of the RT-11 operating system that we noticed, was that when booting up, it had a 1 second spin loop while it waited for the PDP-11 disk drives to spin up. This was totally un-necessary on the simulator and wasted 1 second of IBM mainframe computing. So, we commented out that spin loop on the simulator. That was only modification we made to the RT-11 code that ran under the simulator on the IBM mainframe. And after that, we got another compiler called PL-11, that was written by… by Bob Russell while he was a CERN. It enabled you to write in an intermediate language which was much simpler than writing PDP-11 Assembler language. At the same time, it enabled writing very efficient code (much more efficient than a high level language such as FORTRAN) which was necessary in order to take data from accelerator beam pulses repeating at up to hundreds of pulses per second.
So, I came back, and I joined the central computing networking group at SLAC as their leader. Members of the team included John Halperin, Gary Bauer, Charlie Granieri and Fred Hooker.

At about this time, Al Beeman was running operations. Then Al left and Chuck asked me to take over operations as well. So, I also took over operations and was promoted to Assistant Director of Computing. Operations was a 24 hour by 365 days per year operation with 3 shifts, Day, Swing and Graveyard and included about 20 operators and supervisors. There were 2 operators and a supervisor on days and swing shifts looking after the consoles (on the 2nd floor), mounting tapes and dispatching printout (on the 1st floor) and an operator and supervisor on graveyard managing the consoles and tapes. The supervisors included people like Sock Kuritsubo, Don Crume and Bob Kelley. We would have 2 weekday shift change-over meetings per day at 8:00am and 4:00pm that I would

attend. The operators were all in a union, so it was an interesting learning experience with lots of personnel issues. I do recall Ron Barrett, one of the operators, was heavily involved with the union.

At one time Chuck Dickens was head of computing at both the Stanford University campus and SLAC and would spend his time at both sites. Eventually this became untenable and by 1980 he had relinquished his duties on the Stanford campus, electing to just head up computing at SLAC. He stayed in that role until he retired in 1995-6.

One of the problems I ran into when I came on board in 1980 was the wiring to connect computer terminals to the computer center mainframe. This was managed by Stanford campus technical support. Once we added the Micom data PBX (I'll come to that later) the campus wiring database could not accommodate the twisted pairs in multi-pair cables and punch down blocks that would work with the twisted pairs used by the ASCII terminals connected to the Micom. So, one of the first things I did was to get involved with George Crane, to build a database using SPIRES, to handle this type of cabling. George came up with the concept of a virtual circuit that was mapped onto the wires and cables that carried it from the terminal to the Micom switch terminal port. So with George's help I wrote these SPIRES procedures and formats to actually provide the user front end to allow our technicians to easily access, review, update and provide reports concerning the thousands of connections.

[00:09:50] [2.5s] When I arrived back at SLAC, Joe Wells had just issued a Request For Proposals for a data switch. This was basically like a small telephone exchange, but to connect ASCII terminals and computer ports. Thus, a user at a terminal could tell the data switch 'I want such and such a service' and magically you would get a connection from your terminal to a relevant computer port. And so, the switch was like a telephone exchange with twisted pair cables going all around the site connecting up computer ports and terminals, and with a database to keep track of all that.

Melen [00:10:29] What switch was this with?

Cottrell [00:10:29] It was a Micom [reference: https://en.wikipedia.org/wiki/Micom] eventually.

Melen [00:10:34] Micom --It wasn't Gandalf Technologies [reference: https://en.wikipedia.org/wiki/Gandalf_Technologies] or something?

Cottrell [00:10:36] We looked at Gandalf, we looked at Intercom and we looked at Micom. And Gandalf was the oldest, the most mature; Intercom was the most sexy and advanced; and Micom was in the middle. And we went the middle path and I think it was a good decision. Gandalf was chosen by Stanford. Intercom was chosen by the people at Berkeley. They had a lot of problems at Berkeley. We also had problems and it turned out to be mainly grounding problems, it took months to get it sorted out. After that our system really ran very well and we used it for a long, long time until after the Ethernet came along in about 1985. And then slowly we started migrating to the Ethernet for both terminal and computer access. Even after the Ethernet based terminal servers came into production, the Micom hard-wired twisted-pair cable connections were better since they had a dedicated port and so were guaranteed a character-by-character delivery time at 9600 bits per second. Whereas, if you were connected by an Ethernet server, the access to the connection media was shared and so characters were assembled in packets that had to be queued for the shared Ethernet media adding variable delays. Also, if the Ethernet

server failed, of course, you lost your terminal connectivity. So, for many years the Micom switch stayed in place and continued to be successfully used. The Micom physical connections were looked after by Fred Hooker and his team, including Hector Prado, who were heavily involved in the cabling etc. We also hired Tim Streeter from CERN, who did a wonderful job completing the code that I had started, to actually manage the Micom. In other words, enable you to easily read the state and change the configuration of the Micom without having to log into the Micom itself that only had a single operator's command port. This was accomplished by having a PDP 11 front ending the command ports. The PDP 11 in turn could be accessed simultaneously through the Micom switch by multiple ASCII terminals. The system was also adopted by UC Santa Cruz. We gave several talks and papers on it since it was a very elegant system. So, okay, back to where we were, so on the operations side, when Al Beeman left SLAC I took over the computer operations group and then eventually got someone to run a review of operations on how it should be done and hired her to become the head of operations. She was a Mormon and eventually went back to Salt Lake City.

Melen [00:12:52] What is her name?

Cottrell [00:12:52] Rita Skowronski. When she left, we hired Teri Church to be head of operations, and she hired Sandra in turn to be head of operations and in those days, we still had a team of 20 operators. So, when I was in charge of operations, I wrote lots of scripts to make the job more automated and easier. So, when you wanted to see how things were going, you could enter a command which would take a lot of special internal commands to the IBM Operating System and put them together to make the information much more useful for operations and then Ted worked on ...

Melen [00:13:31] Ted Johnston.

Cottrell [00:13:31] Ted Johnston.

Deken [00:13:31] Ted Johnston, okay.

Cottrell [00:13:31] ...worked on, you know, making many more tools. Also Bill Weeks, Ted Johnston and others were heavily involved in improving the VM operating system. VM came in with the arrival of the IBM 3081, in around 1980 when I returned to SLAC.

Melen [00:13:49] Well, my recollection was in '79 when I... I went to a meeting in February of '79 between campus and SLAC talking about their future, and at that time, SLAC had decided that they were moving off OS/MVT to VM and campus was moving off OS/MVT to OS/MVS.

Cottrell [00:14:07] Yeah, I know we had...

Melen [00:14:10] The technology split for the groups, and so I would say you were probably running VM in test in '78.

Cottrell [00:14:18] Could be. That sounds roughly right. It was also fortuitous for me, since during the year I spent at IBM Hursley much of the computer access was to VM systems.

Melen [00:14:26] Perfect.

Cottrell [00:14:26] So I came back after one year of on-the-job training on VM. And SLAC, at that time, was in the process of moving VM into production.

Melen [00:14:37] Now, was John Ehrman working for you at that time as head of User Services or what were you doing...?

Cottrell [00:14:41] No, John Ehrman was a separate group, he was User Services, User Services was a separate group from our group.

Melen [00:14:49] See here, see John reported to Chuck Dickens.

Cottrell [00:14:51] Chuck Dickens, that's right.

Melen [00:14:52] Ehrman is another person we should try to get.

Cottrell [00:14:52] Yeah.

Deken [00:14:52] Yeah: I've got records from him for the Archives, yeah, we should talk to him.

Cottrell [00:15:02] So let's see, so then we hired Ter Crami, and then later on we went to "lights out," but that required the silos (which are currently being demolished) ...

Deken [00:15:12] You went to "lights out" did you say?

Cottrell [00:15:12] Lights out -- no operators. So, the operators were laid off, some were re-hired, you know, I don't know whether Neal had been hired before that, but some got hired, as programmers or for the help desk.

Melen [00:15:25] You mean like Neal [Adams] and George Maclin.

Cottrell [00:15:29] Neal and George Maclin...Ron Barrett, people like that, got hired into other roles. Others were laid off and we ran with almost no operators, and that was quite amazing, you know, 'cause no longer was there a console on the second floor. However, the paper printout still had to be dispatched so some operators were retained. When did we get the IBM 3081? That must have been the early '80s, I believe it was '81 when it arrived at SLAC. Yeah, I think it must have been about then, and then we got the IBM 3800 printer, but that required a lot of dispatching of paper, so we must have kept at least some operators. But it wasn't like, you know, you have to mount the tape within a set amount of time. Instead, the tapes were automatically mounted from the STK tape silos. But the paper printing was still required dispatching, so several groups by this time were starting to get their own local printers all round the lab.

Deken [00:16:30] So, when did you get the silos, the silos being taken out right now?

Cottrell [00:16:36] '88?

Melen [00:16:38] '88 was the first silo that disappeared earlier this week and was installed in '88.

Cottrell [00:16:44] '88, that's right. So that was to come about that time...

Melen [00:16:46] When the silos were installed with the... Was the 3800 printer also in the same area?

Cottrell [00:16:54] The 3800 printer was on this side.

Melen [00:16:57] Of the glass?

Cottrell [00:16:58] On the other side of the glass...

Melen [00:17:00] Yeah...

Cottrell [00:17:01] Just... Just over here, maybe two feet away from the glass wall and about running parallel to the glass wall.

Melen [00:17:09] So it was there with the silos?

Cottrell [00:17:11] That's right, the silo in this corner.

Deken [00:17:14] So for the benefit of the tape: we are in Conference Room C, and Les is just gesturing at the glass wall that is behind him.

Cottrell [00:17:22] Yeah, that's right. The other big change around this time was the deployment of local area networking. Local area networking was beginning to explode, and Digital, Intel, and Xerox got together and defined a standard for the Xerox developed Ethernet. This then became an IEEE standard, and it really took off. And John Brown's group at SLAC (the Data Division) was also involved in the early Ethernet at SLAC. So, the early development/deployment of the Ethernet at SLAC was a joint effort between Chuck Dickens' SLAC Computer Services (SCS) group, in particular the networking team I led, and John Brown's team.

Melen [00:18:02] They did digitizing of the data?

Cottrell [00:18:02] Originally, they supported the bubble chamber experiments. And they would build devices to read bubble chamber pictures and digitize the tracks. They also managed the scanning tables and provided computing support. As the bubble chamber work at SLAC started to decline they moved into support for Digital Equipment Corporation (DEC) VAXes at SLAC. So, they were helping experiments running at that time to support their VAXes. About the same time, we had a microwave dish on top of the A&E building. It had a link to LBL: there was actually a line of sight from the top of that building to LBL. You wouldn't believe that: it did eventually get blocked by trees, but there was definitely a link, and that was a micro-dish, and so we began to have the first inter-lab DECnet running.

Melen [00:18:58] That was the first one?

Cottrell [00:18:59] That was the first one.

Melen [00:19:00] I don't know if anybody knows that! I've never heard that before.

Deken [00:19:01] It was the first inter-lab DECnet?

Cottrell [00:19:05] DECnet connection. I'm pretty sure it was, it certainly was for high energy physics.

Melen [00:19:09] And maybe even the first inter-lab network?

Deken [00:19:14] So when was that?

Cottrell [00:19:16] That's a good question: that must have been, I'm guessing late 1970's We managed that, and John Brown's team was managing the VAXen, and VMS and they were looking heavily at going to Ethernet. Given our interest in the Ethernet and SLAC and Xerox PARC (the inventors of the Ethernet) being only a few miles apart, I visited PARC and had met with one of their networkers and learned of the capabilities the Ethernet provided and was impressed. So, we set up a team which included John Brown and his people, in particular Mike Huffer, plus Teresa Downey, Tim Streeter, Charlie Granieri and myself from the network team, and Owen Saxton from Group A. I'm not sure who else was on it... The remit of the overall team was to look into Ethernet and the applications to run on it. Initially we couldn't buy commercial Ethernet switches, they didn't exist, so we considered building an early version of a switch. We actually brought some Motorola hardware, with the intention to build a switch similar to one that had been developed at CERN. We never did build it. By the time we kind of got down to figuring out how to do it, switches were beginning to be available on the market, from companies like Sun, Ungerman-Bass, Bridge, and 3Com, so we got right out of that business. What we did do, though, was we recognized that... that VMS had DECnet and Ethernet interfaces, but the IBM mainframe didn't, and then IBM came out with something called the DACU (for Direct Access Control Unit), which enabled connecting items such as a PC to an IBM mainframe channel unit. In our case we connected an IBM PC to the DACU. The PC had an Ethernet connection on it, so then you had a connection between the Ethernet cable and the IBM mainframe channel. So then, of course, we needed software to handle it. And so, we looked at various ways of doing it. And I started out writing a program to try and do this using Pascal, but with managing mainframe operations and networking, it didn't really make as much progress as it should have, but I learned a lot from doing that. And eventually decided, 'Surely we can get something from somebody?'

Deken [00:21:41] Okay.

Cottrell [00:21:41] This was before IBM announced TCP/IP for VM in April 1987. At the time, SLAC had a strong commitment to the XNS protocols supported by terminal concentrators, switches and other networking equipment SLAC had acquired or was interested in that were developed by companies such as Bridge, Ungerman-bass or 3Com. Therefore, we decided in 1984 that network access between the central IBM main experimenters' DEC VAX/VMS computers by XNS was more important than TCP/IP access. We therefore talked to InterLan; a company later acquired by Micom in 1985. InterLan had developed a Xerox ITP Network Software package that implemented the XNS Internet Transport Protocols (ITP) [XNS [reference: https://en.wikipedia.org/wiki/Xerox_Network_Systems] for VMS systems. We talked to them, and they said, 'would you be interested in working with us to... to extend it to run on an IBM mainframe?' It was all written in C, and we agreed to work with them. SLAC put together a team including T. Downey, H. Frese, C. Granieri, M. Huffer, L. Moss, T. Streater, 0. Saxton, and D. Wiser and myself, to work with InterLan to work to successfully complete the port [SLACnet Implementation and Experience https://www.slac.stanford.edu/pubs/slacpubs/3750/slac-pub-3894.pdf]. It was probably the first implementation of XNS for an IBM mainframe.

Deken [00:22:28] InterLan?

Cottrell [00:22:29] I-n-t-e-r capital L-a-n. And they had developed the software for VMS. And so, we worked with them, and we developed XNS for the IBM mainframe. It was the first implementation of XNS to run on an IBM mainframe. We gave talks on it at SHARE [reference: https://en.wikipedia.org/wiki/SHARE_(computing)] and things like that. It was remarkably good, but unfortunately, it wasn't following the general line. Well, everybody in the High Energy Physics community essentially gave up on XNS essentially since XNS wasn't open source. On the other hand, TCP/IP was very much open source and TCP/IP was released with Berkeley 4.2 in 1982,, whereas XNS was not integrated into Unix until a few years later.

Melen [00:23:08] X standing for Xerox...

Cottrell [00:23:51] And so I think we ran the XNS protocols until the end of the IBM mainframes. And that was the main way the IBM mainframes talked to the VMS machines. Owen Saxton was mainly supporting the VMS side, but also helped along on the IBM side. And then, when Unix came to the fore in the academic community, IBM came in with the RS6000 series workstations which ran under AIX an IBM specialized version of Unix. And then TCP/IP came loaded with just about every workstation and the VAX systems SLAC bought, so that kind of was the end of XNS, but it was a good system while it ran.

Melen [00:24:44] When we get near the end, I want to make sure we don't forget to ask you, what you remember about the Comp Group.

Deken [00:24:50] The Computation Research Group, right. Were you involved with them at all?

Cottrell [00:24:55] Oh, yeah. That was a whole history in itself. The Computation Group was started by Bill Miller. He was in charge of Operations and in charge of the Computer Research Group. Now, when Bill Miller left, Bob Braben became head of the Computer Research group. He left after a year and went to UCLA, and then they hired Jerry Friedman [a different Jerry Friedman to the Jerry Friedman who was from MIT and won the 1990 Nobel Physics prize together with Dick Taylor of SLAC and Henry Kendall of MIT], then of LBL, to lead the SLAC Computer Research Group.

Melen [00:25:12] When Miller was here, he was in the Research Division?

Cottrell [00:25:15] Yeah.

Melen [00:25:16] Who was in charge of the Research Division?

Cottrell [00:25:17] Joe Ballam.

Melen [00:25:19] Okay.

Cottrell [00:25:19] Joe Ballam was very smart. He was very hands off, he would give you directions and then he would give you a budget, and he was also very good at making contacts for you, with other people. Like I mean, I would go to other labs to give talks and/or to participate in reviews of their computing plans, so I get a lot of exposure with that. The reviews included the SSC, and I was going down there regularly. Joe really made that happen. He was good at providing me public exposure, so to speak, so that other

labs would be interested in requesting me to talk to them and things like that, you know. Joe Ballam was in charge of the research division at SLAC that included both computer research and operations. Joe hired Jerry Friedman, who came from LBL.

Melen [00:25:59] No: Miller hired Friedman.

Deken [00:26:02] Or Ballam?

Cottrell [00:26:02] I thought...

Melen [00:26:03] Was it Ballam?

Cottrell [00:26:03] Actually, I don't know, it might have been Miller, it might have been… by that time.... I'm not sure whether he came before Ballam, before Miller left or after, I imagine he came after Miller left.

Deken [00:26:15] Jerry Friedman did come after Miller left.

Cottrell [00:26:15] Yes.

Deken [00:26:17] I did look that up.

Cottrell [00:26:18] Okay. So, I imagine he was either hired by Chuck or hired by Joe directly, I don't know.

Melen [00:26:24] Did the Computer Research group exist before Jerry got here?

Cottrell [00:26:27] Yes, it did. But it was under Bill Miller.

Melen [00:26:28] Directly under Miller?

Deken [00:26:28] Yes, he was the head.

Cottrell [00:26:28] So Jerry Friedman came in and he had a joint appointment with the campus, I believe, and he had a lot of students, some of whom became quite famous. There was Lenny Shustek [reference: https://en.wikipedia.org/wiki/Len_Shustek], who in the mid-70s, worked on developing an emulator to emulate and run on the IBM mainframe. Since it was an emulator, it ran much slower than the native IBM, but one could trace instructions, insert break points etc. Later on, he developed something called the Smart Terminal. It took the ideas of the Tektronix 4010/4016 storage tube graphical terminal and by using an Intel 8080 microcomputer, a frame buffer, interlaced raster display and keyboard, basically created the first raster scanned display terminal. This type of display became standard for inexpensive graphics workstations in the 1980s.

Melen [00:27:11] Was this… this was even before...um...Andy?

Cottrell [00:27:15] This was, um...

Melen [00:27:17] Andreas?

Deken [00:27:17] Andreas Bechtolsheim. [reference: One of the four founders of Sun Microsystems]

Cottrell [00:27:17] OK. So, Andreas Bechtolsheim, OK, so they were continuing...at the same time…

Deken [00:27:24] Contemporaries?

Cottrell [00:27:24] Yes: contemporaneous. I think Lenny Shustek spent a lot more time at SLAC than Andy did. Andy was working for Forest Baskett, who was the head of... I don't remember what he was the head of, but he was a professor on campus, and he... he spent a lot of time at SLAC.

Melen [00:27:45] Baskett did?

Cottrell [00:27:45] Yes. Baskett went to work for SGI as the head of research, when he left campus. Lenny was working heavily with myself and with Marty Breidenbach. Forest Baskett, and Andy Bechtolsheim, were more separate from us. But they were working on… they helped Lenny on the design of the terminal, and I think they were working on campus, too. And of course, then...

Melen [00:28:16] Bechtolsheim and Baskett?

Cottrell [00:28:18] Yeah, and then Bechtolsheim left campus and joined...

Melen [00:28:21] He was co-founder of Sun.

Cottrell [00:28:23] Co-founder of Sun, that's right. He was one of the three.

Melen [00:28:25] Of the four.

Cottrell [00:28:27] The fourth was the guy with the money...

Melen [00:28:30] Scott....

Deken [00:28:31] McNealy?

Cottrell [00:28:31] Scott McNealy, Bill Joy, from Berkeley, who was.

Melen [00:28:35] The software...

Cottrell [00:28:36] The software guy....

Melen [00:28:37] Andy Bechtolsheim...

Cottrell [00:28:37] Who was a hardware guy.

Melen [00:28:38] And I think there was a Vinod [Khosla]? and I think he's now a venture capitalist?

Cottrell [00:28:42] That's right: who put in the money and got it all together. So, they founded Sun. Other guys who were... There was another guy who was working here and went to work for Motorola...

Melen [00:28:57] Skip Streeter.

Cottrell [00:28:58] And Len Shustek who went on to found Nestar with Harry Saal who was also previously at SLAC.

Deken [00:28:59] I've got a list of the names. [Presents list of authors of CGTMs]

Cottrell [00:28:59] oh, yes. Oh, okay. Right. So, Sam Howry, yeah, beam switch yard that's right... John Ehrman, yeah... I don't remember ...

Deken [00:29:12] So, where did Skip Streeter go?

Cottrell [00:29:19] Skip Streeter went to Motorola and designed the Motorola 68000, which was one of the two major microcomputer chips at the time. There was also...Who was the guy who did the graphics? MaryAnne Fisherkeller and...

Deken [00:29:32] MaryAnne Fisherkeller and ...um... Tukey, John Tukey.

Cottrell [00:29:34] John Tukey was there, yeah...

Deken [00:29:34] He came on sabbatical, right?

Cottrell [00:29:37] He came on sabbatical, invited by Jerry Friedman, and spent a lot of his time on user interfaces and projection pursuit, graphical interfaces for doing projection pursuit working with Jerry Friedman. That actually went very well. Then there was John Welsch who studied the details of the IBM 360 architecture. And John Ehrman who wrote several papers and taught students on the IBM 360 System assembler, and others on understanding the IBM 360 architecture.

Melen [00:30:06] Was there a Burroughs here?

Cottrell [00:30:06] I don't know. I recall using a Burroughs computer, but I believe that was on the Stanford campus. On the other hand, Ed Satterthwaite of the SLAC Computer Research Group wrote an article in 1968 on converting Burrough 5500 Algol to Algol W.

Melen [00:30:13] There was one down on campus, so maybe that's possible?

Cottrell [00:30:20] John Ehrman, I remember him, too.

Melen [00:30:27] Ehrman wrote a lot.

Cottrell [00:30:28] Yeah. [unintelligible] The bubble chamber Spiral Reader, that was developed by John Brown and his team. And the SLAC Computer research group helped with the software.

Deken [00:30:52] Okay.

Cottrell [00:30:52] It was really very early, I'll say.

Deken [00:30:52] Something called "PEEL"...

Cottrell [00:30:52] Don't remember that. [Later looked it up, Peel was an exponential editing program written by …]

Melen [00:30:52] Lyle Smith...

Cottrell [00:30:58] A lot of these names I don't remember them all... John Steffani... John Steffani was the guy who wrote the PDP11 cross assembler and link editor that ran on the IBM mainframe.

Melen [00:31:11] Octavia...

Cottrell [00:31:11] That was a Microprocessor Assembler Language for the Standard Computer Corporation MLP-900. It was a unique machine designed to emulate other architectures. The machine was never delivered to SLAC and instead Standard delivered a predecessor, the SC7000 which was similar. Harry Saal and Len Shutsek were big users of it. Which, several years later, I shut down since we needed the space, and it was no longer used! [laughs]

Cottrell [00:00:00] Another Nobel Prize winner who was at SLAC for some time, and then went back to Brookhaven, Mel Schwartz.

Deken [00:00:07] Oh, sure.

Cottrell [00:00:08] And I think they founded a company, I think... I'm not sure about this, this may need checking.

Deken [00:00:16] Okay.

Cottrell [00:00:16] But I think they founded a company that was into security and encryption of data.

Melen [00:00:21] Network General?

Cottrell [00:00:22] It could be Network General.

Melen [00:00:24] Was that it?

Cottrell [00:00:25] Yeah, I think it was Network General. Lenny Shustek founded the company that did sniffers. I've forgotten what the name of that company was....

Melen [00:00:34] [unintelligible].

Cottrell [00:00:34] Bob Stewart [?] was at Network General... You might want to get... Lenny Shustek is still around.

Deken [00:00:39] Yeah, he was at The Computer History Museum.

Cottrell [00:00:40] Yeah, that's right. So, you might want to get him... Or here's Bob Beach, SLAC Unified Graphics.[1] He was an interesting guy, he… He was a perfectionist, and his, his software was always perfect, but he, he would never... If the hardware didn't work, he just went over the top, you know, and we got new software, this hardware system from CalComp, which was interfaced to the IBM mainframe, I don't remember if we got version one or what, but he really killed people at Caltech, I mean CalComp, because it so badly, it didn't do what it was supposed to do, and he had to program around it, yeah.... Oh, Jim Cook!

Deken [00:01:26] Jim Cook, Yeah.

Melen [00:01:26] [unintelligible] Telecomm.

Cottrell [00:01:27] Yeah. Jim Cook was a… interesting guy, he was from Texas. Roger Chaffee, yeah. Jim Cook... (They both died of cancer.) Jim Cook was from Texas, and he was very proud of it. He used to smoke like a train. He had an office where, let's see, where what-was-his- name used to be in it: the guy, the last member of what used to be...

Deken [00:01:52] Frank Rothacker?

---

[1] For this portion of the interview, the group was reviewing the list of authors and titles of the Computation Research Group Technical Memos (CGTMs) listed on the web at https://www.slac.stanford.edu/history/cgtm.shtml.

Cottrell [00:01:53] Yeah: Frank Rothacker. That was his office. And he wrote this Mortran compiler.

Melen [00:02:00] He did Mortran? Mortran was done here?

Cottrell [00:02:00] Oh, yeah.

Melen [00:02:03] I did not know that!

Cottrell [00:02:03] Mortran was brilliant.

Melen [00:02:05] Mortran was a structured Fortran, right?

Cottrell [00:02:07] That's right. That's right. You would write in this language, it was structured with "if," "then," "else," and you know, "begin," "end," and things like that. And it would generate Fortran and basically the bootstrap consists of a single card, and we were always proud of this, and so you could bootstrap it from one card, and we were always trying to keep it working that way because it would slowly grow, you know, from that. But it was used heavily, it was taken to CERN. We used it very heavily in Group A, a lot of our code was written in Mortran, and it was very nice, but it no longer exists, you know. In fact, we wrote a lot of our code in Mortran and then Adam Boyarski had to convert, wanted to upgrade the histogram package that we worked on together called HPAC, or it's called [?], and he wrote something called.

Melen [00:03:02] HANDYPACK.

Cottrell [00:03:03] HANDYPACK, which was, because there was an HPACK and a DPACK. DPACK was the database...

Melen [00:03:06] Oh, "H" and "D" pack… Oh, I get it! You know, I never realized...[laughter]

Deken [00:03:09] HPACK And DPACK: HANDYPACK. Oh, okay.

Cottrell [00:03:09] So he had to rewrite all of the code, and he rewrote it, but he took it out of Mortran and put it back in Fortran, he didn't like Mortran. So, so it went both ways on that one. And then Roger Chaffee took...

Melen [00:03:31] Universal Graphics.

Cottrell [00:03:33] Took Universal Graphics and wrote a brilliant front-end, TOP DRAWER in particular for that. TOP DRAWER, here, that was that was heavily used at SLAC for creating graphs and it was used in papers, it was publication-quality graphics you would get out of it and you could also use it for other things. I used it for many a year until we got some better tools, until basically we had, you know, things like Excel and things like that to create the graphics. Yeah, okay, Bob Beach… These are probably the only remaining members… Oh, Chuck Zahn, yeah, he was around for a long time, yeah, User Manual...

Melen [00:04:10] You can see just back here, so... Jerry suddenly starts to appear here talking about his ...his… [multiple voices-unintelligible]

Cottrell [00:04:20] He was at CERN at the same time I was at CERN, so he must have got back from CERN around that time. And Chuck Zahn was at CERN, too, we were all there at about the same time.... Lenny Shustek, oh, the Video Graphics Terminal, VGT ....

Melen [00:04:34] The Internals of ....

Cottrell [00:04:35] Yes... one... one really neat thing on that, which was that you would want to scroll the text.

Deken [00:04:45] Uh-huh.

Cottrell [00:04:45] And so Lenny got hold of a... A trackball that came from the...from John Brown's group who would do bubble chamber scanning, and you could spin it...

Deken [00:05:00] oh, uh-huh.

Cottrell [00:05:00] And you would spin it fast, and the faster you span it the quicker the text would move up the screen. And if you think about a... A smartphone, an iPhone today, we all scroll up, we do this, it was pretty much the same thing...

Deken [00:05:14] The same thing!

Cottrell [00:05:14] Except with this spinning ball...You could stop it, you know, and the thing would stop, and you can start scrolling again. It was big, it was clumsy, but it was very nice. Forest Baskett...

Melen [00:05:23] Here's a Forest Baskett paper...

Cottrell [00:05:23] Oh, the Triplex... Okay. Raj Raffii... I don't... I think his first name is Raj, but I don't remember anything about him, but the name comes back. Yeah. I don't know what that was... SPRINT. Oh, I remember this one...

Melen [00:05:37] SPRINT?

Deken [00:05:40] SPRINT?

Cottrell [00:05:40] Interactive... For printed circuit design...

Melen [00:05:42] I think I know this guy, Bill VanCleemput...

Cottrell [00:05:46] Could be...

Melen [00:05:46] I think I know him from down on campus.

Cottrell [00:05:47] Yeah. Because I remember around this time, actually a bit before that, when I came back from CERN, there was a guy who used to be at the Artificial Intelligence Center up on the Hill.

Melen [00:05:58] SAIL.

Cottrell [00:05:58] SAIL, that's right. Which then...

Deken [00:06:02] S-a-i-l?

Cottrell [00:06:02] S-A-I-L.

Melen [00:06:02] Yes: Stanford Artificial Intelligence Lab...

Cottrell [00:06:06] Was it up in that building? I'm not sure... It was up on the hill up there. Yeah. He had written this is...what do you call it... not PC board, but a wiring board layout program, and we were doing a lot of wire... basically, you'd have a board with lots of holes in it, and pins you stick in the hole, and then you get wire to come along, and wire wrap and you connect up a few things on it...

Melen [00:06:30] That's what that was all about at that point...

Cottrell [00:06:32] This was pre-circuits, that's a different one... So, but so, I took his program and got it to run on the IBM mainframe. Joe Zingheim and other people at SLAC would use it for, you know, developing prototypes in wire-wrapping. It worked very well, so we used it for many years, but then of course, printed circuits came along and then we didn't need it anymore... Oh, this is, yeah, this is where he was...

Melen [00:07:00] Shustek's paper on Connecting Computers to WYLBUR...

Cottrell [00:07:00] So, we worked with him on that. So, he helped us a lot on that.

Deken [00:07:04] So, Shustek was a graduate student?

Cottrell [00:07:07] He was a graduate student at the time. Yeah. Very, very smart. He... Another, oh yeah, there it is... is... WORMON. This was the... alright, I'm not sure if this is the… He had another thing... Yeah, I think it was. So, you were able to take your Fortran program and put it through his stuff and then you would be able to see where all the time is going, and you'd be able to start to optimize your program. Another thing he did...

Melen [00:07:35] Look at this one here...

Cottrell [00:07:35] Was build an interactive debugging, yeah, DEMON, yeah, he wrote that, too. That was really useful. I was using this all the time to debug our programs, and you know. Until this, you know, it was 'well put a print statement in here and we'll see if it gets used,' and then you'd have this, and you could actually really start to debug it very nicely. That… that… that was probably one of the first interactive debugging systems to ever hit the field.

Melen [00:07:59] He contacted, actually, through Don Lemma, a couple months ago contacted us. He was looking for some of his stuff that would have been on tape, as I recall.

Deken [00:08:08] Yes, yeah: he was looking for some tapes...

Cottrell [00:08:12] Oh...wow...my goodness...

Melen [00:08:12] Well, Jean has a surprising number of tapes in the archives, but we couldn't clearly put our hands on what he was looking for...

Deken [00:08:20] Yeah, we couldn't...we couldn't find anything.

Cottrell [00:08:21] Yeah. I mean to say, these were both major efforts, yeah, and he did do...

Deken [00:08:28] So which two are the major efforts?

Melen [00:08:29] DIVONNE ... oh, DEMON, pardon me...

Cottrell [00:08:33] I'm not sure how heavily this was used...

Melen [00:08:36] And WORMON...

Cottrell [00:08:36] But those, DEMON, WORMON, and then of course his 'Connecting Computers to WYLBUR,' that... We used that heavily. He helped us a lot with that. Too... he and Mark [unintelligible]...

Melen [00:08:46] 1977 was a big year for Len Shustek...

Cottrell [00:08:46] Yeah... I never used this; I don't think...

Melen [00:08:52] ABACUS?

Cottrell [00:08:53] Yeah.

Melen [00:08:54] Did he write the expression evaluator?

Cottrell [00:08:54] There were around at the same time. Forest Baskett...

Melen [00:08:56] Yeah.

Cottrell [00:08:56] I, yeah, I don't think... I'm not sure that's what's-name ever had a paper here...the guy who went and found SUN... I don't think he's in here...

Melen [00:09:00] Andy Bechtolsheim?

Cottrell [00:09:00] Bechtolsheim. I don't see him... 'Stanford PASCAL Compiler'...

Deken [00:09:17] Roger Chaffee?

Cottrell [00:09:18] ... Oh, Henk Wind! Was he… was he here for a year?

Deken [00:09:26] (This is paper 201...)

Cottrell [00:09:27] [unintelligible] ‘cause I met him at CERN... I don't know what that paper was, but he was... He was the ultimate mathematician, you know, and he was head of the [uni's?] principal component analysis, he must have been at SLAC then for a while... Oh, that never happened [CTGM202--cancelled] ... OK, Bob Beach... Bob Beach... Bob Beach...

Melen [00:09:45] See, he redid VM/CMS...

Cottrell [00:09:46] Oh, yeah.

Deken [00:09:46] ... MORTRAN...

Cottrell [00:09:47] CalComp Graphics...oh yeah. MORTRAN-3 ... We're getting to the end of MORTRAN, now. And 'What's Wrong with FASTBUS?' Oh...

Melen [00:09:57] From Dave Gustavson.

Cottrell [00:09:58] Yeah, he was big on the FASTBUS.

Melen [00:09:59] FASTBUS, and then he was also big on that interconnect... that low-latency interconnect that Dalton finally picked up?

Cottrell [00:10:07] Oh, SCI.

Melen [00:10:07] SCI, thank you... and he was involved in the standards for SCI...

Cottrell [00:10:11] That's right, yeah… Oh, so we got up to about 1980, I think. (Laughs). After '80 we got the 3081, we got the 3800, more and more printers out in the field, so eventually the 3800 wasn't needed anymore. Let's see, uh, when did the IBM RS6000's come in? Was that in the 90s?

Melen [00:10:36] Probably the early 90s.

Cottrell [00:10:37] Yeah, I think it was. IBM made us an offer we couldn't refuse… or didn't refuse. We got… we got a lot of RS6000s...

Melen [00:10:46] Which were turned into Unix workstations.

Cottrell [00:10:46] That's right. There were all kinds of committees, not all kinds, there were committees set up for how we're going to move to UNIX. Paul Kunz was heavily involved in that. If you ever get a chance to...you can probably interview Paul.

Deken [00:10:59] Yeah...

Cottrell [00:10:59] Because he has a lot of stuff on the move to Unix, he was heavily involved in that...

Melen [00:11:07] I'm going to have to end this very interesting discussion to go over to a meeting over in the Director's office.

Cottrell [00:11:12] OK, good luck.

Deken [00:11:14] Sorry.

Melen [00:11:15] That's OK.

Deken [00:11:16] Thank you very much.

Melen [00:11:17] We've got lots of other names to follow up on that you may want to use some of them as group interviews, I don't know.

Deken [00:11:23] Yeah, yeah.

Melen [00:11:24] And you get stimulation back and forth.

Deken [00:11:26] Right, right.

Cottrell [00:11:26] ...the names… Cause I'd forgotten about the Comp Group, yeah. The whole issue there with the Comp Group is interesting. Have you interviewed Jerry?

Deken [00:11:35] I interviewed him about PRIM9 when I was new here. But I haven't interviewed him since.

Cottrell [00:11:40] Oh yes, PRIM9, yep, yep.

Deken [00:11:40] ...About his work on that.

Melen [00:11:45] Okay, Thank you both!

Deken [00:11:45] See you later--Thank you.

Cottrell [00:11:45] Oh, so, where were we? Oh, 1980 and 1990s? Yeah, oh Chuck Dickens retired in about 1995, then I was acting director for a couple of years, and then we hired Richard Mount... Richard Mount, then the new lot came in, but I can't remember when that was -- not so long ago, but there's plenty of people who can tell you when that was...

Deken [00:12:13] Right, right.

Cottrell [00:12:15] And what else was there that was interesting? I'm sure there's other stuff... I should... I should... I mean, I've got lots of talks given in the 80s and the 90s about the computing at SLAC, ‘cause I was in charge of the computing at SLAC, and so there's...you know, one can gather dates from that.

Deken [00:12:37] Okay.

Cottrell [00:12:37] So I could... I mean... I don't use the decks anymore, and I could give them to you...

Deken [00:12:43] I could copy them, or...

Cottrell [00:12:43] I could probably give them to you, because you'll probably keep them much better than I will. I've got a rack full of talks and some of them are quite interesting because they show the state of things at that time.

Deken [00:12:55] At the time, yeah.

Cottrell [00:12:55] So I get you those... And you may have questions, of course, that may open up a whole load of other things which were going on...

Deken [00:13:04] We could do a follow up, maybe, after I've gotten them.

Cottrell [00:13:05] Yeah. I think it would probably be good after you got that, I should do a follow up. I've also got a 37...no... a 36? 7? a 3705 console... I think it was a 3705, which was the console used by which serial Linux bases/faces? would connect into the IBM mainframes. It had a separate box that you would connect into, at speeds up to ninety-six hundred, which of course was blindingly fast in those days. [Reference: https://en.wikipedia.org/wiki/IBM_3705_Communications_Controller]

Deken [00:13:36] Yeah.

Cottrell [00:13:37] The original modems that we got at SLAC would run, I think... I don't think we got one of the early ones: the original modems would only run at 70 bits a second, then I think we started around 300 bits a second, and they would have acoustic couplers: you would take the headset, and you'd jam it into...

Deken [00:13:52] Jam it into the rubber cup...

Cottrell [00:13:53] And then you would dial up, and you would make the connection and then you have a few hundred bit per second, so that you could have a quote "portable terminal," which was actually... Came in a box which was about this high -- that by that -- so it'd be about two feet or about four feet...

Deken [00:14:14] And that was considered "portable?"

Cottrell [00:14:16] And you'd put it in this box... It had wheels...

Deken [00:14:21] I see -- wheels. I see. [Laughter].

Cottrell [00:14:22] Lift it into the back of your car and you'd take it home, and then you would use it at home with a dial up modem, and you'd be able to get into WYLBUR and you'd be able to do work at home. And what would be interesting, but I can't remember exactly, was the first email system we had...

Deken [00:14:41] Oh, yeah!

Cottrell [00:14:41] And I think it was actually on the 360... 360… no, 370/168... And I believe it was developed by a guy called Ed Frank. I've lost contact with him. He was a student at the time. Ginger-haired guy. He went to work eventually for Sun. He was heavily involved in the development of Java. He was the hardware side of Java and when Java was developed at Sun, it was developed as a language to run on hardware such as would be controlling TVs... And TV-type devices. Cause he went on.... And so he was heavily...I don't know when this was… but whenever, in the early days of Java, he was heavily involved with that. But I believe he developed the first email system, writing on it, I believe a 370/168. And then after that, when we got the 360... the 3081 and VM, I believe that George Crane developed the email system...

Deken [00:15:53] Okay...

Cottrell [00:15:53] And then of course, it became a product, you know, and so, you know, so it moved over to Microsoft and stuff like that and some things like that. So we were one of the early people that had email. Oh, the other thing that we had, which was early on... This was before the Internet, well before the Internet struck SLAC. I forget when we got our first connection to the Internet, I'd have to dig back.

Deken [00:16:16] Okay.

Cottrell [00:16:16] It was in the mid 80s, I think. And we got our Internet connection through Stanford. We had another microwave dish on the roof of this building…

Deken [00:16:26] Okay. Building 50.

Cottrell [00:16:28] Building 50. Which talked to a microwave dish on the -- I don't know how you spell it -- I think it was K-e-c-k, which was the chemistry building on campus...

Deken [00:16:37] Okay.

Cottrell [00:16:37] And provided a… ethernet connection from there to here, and hence at their end, to the Internet.

Deken [00:16:46] Oh, okay.

Cottrell [00:16:46] So, that was our first Internet connection. And I remember arguing at the time that 'we needed to do this' and people were saying, 'why do we need anything more than a 9600 baud modem?' And I said, 'eventually, we might, I think.' [Laughter].

Deken [00:16:59] You think! [Laughter].

Cottrell [00:17:03] And so, we did it. And actually, it was... It was a ten-megabit connection, and it was actually a full ethernet connection, so it was way over anything we needed. But it did give us that... Now, prior to that, we had something called BITNET. And BIT stood [for] "Because It's There" and it was based on an IBM protocol...

Deken [00:17:26] Because it's there?

Cottrell [00:17:28] Yep.

Deken [00:17:29] Okay.

Cottrell [00:17:29] And it connected up all the uni... not all, a lot of the universities. So, there were about, you know, 200 universities in the US, and then it migrated to Europe, pushed by IBM, and hooked up many of the universities there and it was the way in which we would send e-mails to everybody. So this was this was after Ed Frank's work, cause Ed Frank's work was basically email, but only on site, and only if you were connected to the same machine, you know, it was very simple email. So then, we had email between the sites. It also had the capability for you to do interactive messaging, so it must have been one of the early interactive messaging things. So, you're able to, if somebody else was logged in, you were able to send a message, 'are you there?' And they say, 'yes' and you say 'well, can you help me with this' and they'd say 'yes,' as opposed to doing by email. So that... that we'd probably gone to BITNET probably, I'm guessing 1981, 82. And that opened up, you know, our connections to other labs. We were one of the early labs to be connected to BITNET; we were not the first. I think the first lab to be connected to BITNET... It was something like Argonne...

Deken [00:18:45] Oh, okay.

Cottrell [00:18:45] But I wouldn't swear to that. And... is that true? Or were we the first on line? No, I don't think we were the first, and we...we certainly weren't the first lab to be connected to the internet... I think Brookhaven might have been before us, but I'm not sure of that.

Deken [00:19:01] Okay.

Cottrell [00:19:03] So, that was the other network, and it ran for many years and in the early days, we all had another network, which was just point to point links. We would have a dedicated phone line from, let's say, here to Santa Cruz or from here to the University of Colorado, which we would have modems at both ends and that this would give us a connection between the two. And we extended that idea to China, remember the China connection?

Deken [00:19:27] I remember, yes, I do remember that.

Cottrell [00:19:28] So that... that went... So, as I say, we extended that idea to China and that's how we got... got them connected to the Internet. That's a whole different topic, which I think you've probably got enough information on that.

Deken [00:19:40] Yeah, I've got a good idea on that.

Cottrell [00:19:43] I... I think that's probably it. I'm sure I'll think of other things....

Deken [00:19:49] All right.

Cottrell [00:19:49] I'll get you the slide...the books on slides, and I don't know what you can do with them, cause, as I say it's about a shelf-full.

Deken [00:19:55] That's all right. We'll take them: I can get you a couple of boxes.

Cottrell [00:19:58] OK, I mean, as I said, they are labeled by year.

Deken [00:20:03] OK.

Cottrell [00:20:03] So you can go back...Now, typically they may address one topic that I was heavy into that year, like light-side[?] computing, but you'll see how it light-side [?] computing happened, and we were selling the idea to the Digital Equipment Corporation at the time, and they were going to fund something, but eventually it all fell through, you know, like a lot of these things.

Deken [00:20:26] I've never heard that term, "light-side computing"...

Cottrell [00:20:27] Oh, okay. It just meant that there were no operators...

Deken [00:20:28] Without an operator.

Cottrell [00:20:28] ...and if you go to the second floor, there's nobody there; you go to the first floor, there's nobody there. And that was quite novel at the time, I mean, the way computers were run, you had to... you know, the people sitting at the console, watching to see if anything was going wrong, watching a screen. You had another person tearing off paper and then a third person mounting tapes and probably the person doing paper would

only tear off the paper once an hour and would be helping with the tapes the rest of the time. So, as I say, it was a staff of about 20 or 21 people, which was quite expensive. So, there was a big saving when that ...went in. So, basically, it paid for the silos.

Deken [00:21:09] Ah: okay.

Cottrell [00:21:09] Because... And it was a continuous saving, as opposed to a one-time cost.

Deken [00:21:12] Sure.

Cottrell [00:21:13] So that's... That's how we were able to afford the silos...

Deken [00:21:17] Afford the silos. Very cool. OK, well thanks very much.

Cottrell [00:21:20] Well, hang on to this because, this is good because it brings back memories...

Deken [00:21:24] Yes.

Cottrell [00:21:25] Sam Howry didn't leave so long ago...

Deken [00:21:27] Howry?

Cottrell [00:21:27] Howry. Sam was his first name, but I don't know where he went... I don't know who this is … but I remember...I'm pretty sure his first name was Andy...

Deken [00:21:34] Burfine?

Cottrell [00:21:36] Yeah. I don't know much of... This was John Welsch...I knew him a bit... Bill Miller...Bob Braden... Bob Braden went to, um... He's still around, not at SLAC...he went to UCLA, and it was very big in the Internet. And you probably, if you did a Google search on Bob Braden, you would find out he's been heavily involved... He became quite famous. So, he, as I say, he started here. I have a feeling that part of his role was managing the operations, and I don't think he liked operations, he was more of a researcher, and I don't think SLAC was too happy with these managing of operations, and I think it was a mutual parting of the ways. But when he went to... Became really research, he became quite famous, and obviously well respected. That's a little bit hearsay. I've seen him since, and I've talked to him, you know, he doesn't know me, but I, you know, I saw him with his thing and I said, oh, you were at SLAC at one time, so we… we talked a bit about that. So, I have met him, I have talked to him. But I doubt he knows me from a hole in the wall...

Deken [00:22:54] Okay. All right, well, thank you very much.

Cottrell [00:22:58] Sure.