Oral History of Bill Gunning

Interviewed by:
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Randall Neff: We're at the Computer History Museum in Mountain View, and we're talking to Bill Gunning who is one of the engineers and developers of the Johnniac computer at the Rand Corporation in Santa Monica starting in the mid 50s. So welcome, Bill.

Bill Gunning: Thank you.

Neff: I'd like to start out with you background and how did you end up at the Rand Corporation?

Gunning: Well I was in Santa Monica when I graduated from high school, and during that last year of high school I was acquainted with some hams, and we learned, you know, ham radio. What it's like. And one guy was one of the old timers with a two letter call. Anyway, that was a good thing. And then I was-- I got into UCLA and went there for six years, until 1930-- Started in 1935 and finished up in 1941. As an undergraduate, it was physics and…

Neff: Math?

Gunning: Is it going to do this to me? Anyway, I was at UCLA where they didn't have an engineering department, so I was just in math and physics. And worked in radio repair stores. Those were the days when you'd repair stuff instead of throwing it away. And the reason I bring this up is that one of the things that we worked on in the Johnniac is to try to make it easy to repair when something fouled up. And the thing I remember about fixing radios was that you'd almost always in a radio shop hear one or two radios sitting there, and it would have a intermittent, and you'd run over and put the meter on it and it would…

Neff: Fix it.

Gunning: … like fix it. You know that? Okay. That was one of the things that is-- a fader, a radio that fades is hard to diagnose.

Neff: Right.

Gunning: Okay. So then in 1941 I was at-- I went to Douglas Aircraft, Santa Monica. In '41, I forgot when it…

Neff: December the 7th, 1941. A day that will live for infamy. Yeah.

Gunning: Yeah. And so that's where I went to work in 1941, at Douglas. And that's were the Rand Corporation was originally Project Rand, as a part of Douglas Aircraft. And maybe it would help if I could read this stuff. And while there, I had a chance to design and build and use test instruments, flight test instruments. I remember one of them was an analysis of a deicer for the windshield, a real problem when your one final and there's just enough so that the ice forms, how do you regulate the energy that you feed into the heater that's built in as part of the wind shield. Is this the kind of stuff?

Neff: How did you get to Rand?

Gunning: Yeah, I was at Douglas.

Neff: Which became?

Gunning: RAND. Well Douglas-- that's right. Rand was formed in there. There were some other things. There were-- the beginnings of analog computing was going on, having to do with guided missiles and how do you steer this stuff.

Neff: Was this using mechanical, or electronic?

Gunning: No. Well, both. The mechanical ones were-- yeah. They were both. And essentially the electronic ones were assimilating the mechanical ones.

Neff: Okay.

Gunning: And then Rand was formed and there were the-- interesting Rand guys are wandering around in this airplane factory. Then Rand was moved. When it left Douglas, it went down into Santa Monica also. And the people at Rand decided that analog computing was going to be useful because they were being flooded by requests to do computation. And so there were-- the kind of computing that you could buy were IBM punch card stuff and analog computers. And we-- Rand bought one and we called it a REAC, Rand Electronic Analog Computer. Everything ends in 'AC'. And that was delivered in 1948, and while we had it we were working on it because we saw the opportunity to make it work better. But it got to the point where we could see that it wasn't going to be the best. And that digital computers were somehow going to come along. And Johnniac, the things we put on it were a removable patch panel. Because originally these analog computes were like telephone jacks, and that was the problem was what was connected to what.

Neff: So you went to a plug panel configuration for it.

Gunning: Yeah. A board that you could take it out and somebody could work on his problem at night instead of having the thing sit there idle.

Neff: We have some examples in our collection of analog computers with removable front panels.

Gunning: Yeah.

Neff: Not on display, but we have some here.

Gunning: Right.

Neff: And so you were using IBM punch card stuff?

Gunning: You mean in the analog computer?

Neff: No. At Rand Corporation.

Gunning: Yeah. Rand was-- the IBM computing that went on there was seven days a week. No, wait that isn't even right. Oh yeah, seven.

Neff: Punch cards.

Gunning: Punch cards. And they were doing more computing cycles there than everywhere, according to the stuff I've heard. And we used IBM hardware to build a patch cord, because it had to have lower electrical leakage. The analog leakage was noise in the computations.

Neff: Yeah, that's right. So when did you first hear about ENIAC?

Gunning: It would be about that time.

Neff: Okay.

Gunning: When was ENIAC?

Neff: 1946.

Gunning: 1946.

Neff: Yeah.

Gunning: Yeah. That was right.

Neff: Okay. Did you ever see it at the Moore School of Engineering, or at Aberdeen Proving Grounds?

Gunning: I think so, but you know it was like "Oh, there's the ENIAC."

Neff: Okay.

Gunning: And it was enormous. So anyway at that time Rand decided that the digital computers were going to be the thing. And they analog computer was in the basement of the Rand building and it solved a few problems, but not as well as they could see it could be done with a digital machine of the kind that the Institute for Advanced Study was the forerunner of.

Neff: So what kind of problems was Rand solving? They were under contract to the Air Force, so what sort of problems were they solving?

Gunning: I don't know.

Neff: Okay.

Gunning: I think that some of them had to do with-- well they were a contractor to the military. But Rand was really broad. And I don't know Paul Porter, was that who was here? He's a fellow of the History Museum, and he did the talk couple of weeks ago.

Neff: Paul Baron.

Gunning: Paul Baron. That's it.

Neff: Okay. All right, yes.

Gunning: And he talked about the kinds of problems he was doing under RAND contract. And they were a great place.

Neff: Okay. So at some point you got to meet John von Neumann?

Gunning: That's right. For not very long. He was very busy at RAND when he was there, but he had had a chance to do the ENIAC study and propose a machine that…

Neff: Yeah. With the Institutes advanced computers.

Gunning: Yeah. That's right.

Neff: We have those reports on him.

Gunning: Okay. Well we went on, George Brown, who's at UCLA now I think, and John Williams who was at Rand, and I toured the country looking at the IES machines and what else was being built. And decided to recommend to Rand management that they try to build one. A very gutsy thing on their part, I mean, here we'd just spent a bunch of money on building an analog computer, and we're saying "Well that's not going to do." And we did. And you'll find in that history of the Johnniac, some information about that, particularly John Williams' notice to the Rand management.

Neff: Well it's always seemed to be an incredibly gutsy move for Rand to go build the computer because there was only a handful of working machines, a couple in England, an ENIAC and one's following John von Neumann's design. It's just a handful of machines…

Gunning: That's right.

Neff: …and yet for a research corporation to go and say "We're going to build this brand new toy." Plus convincing the Air Force to fund it seems very remarkable.

Gunning: Yeah it is. Now Baron can fill you in some other things that were going on right at about that time, but it, especially in retrospect, it seems wonderful.

Neff: It does.

Gunning: Yes.

Neff: So how did they do it?

Gunning: Well, we said-- we went to Eckert and Mauchly, and we to other places besides the IES machines, and we were convinced that you could make one of these things and make it work. And they bought it.

Neff: It's amazing.

Gunning: Yeah.

Neff: Because it was very risky.

Gunning: Yes it was.

Neff: And very expensive.

Gunning: And very expensive.

Neff: To build it.

Gunning: I was fortunate enough not to know how much, you know.

Neff: It's spelled out in the report. It's like in the order of a million dollars in the late 1940s. I mean that's an immense amount of money.

Gunning: Yes. Yes.

Neff: So, okay. So you started out with finding one of these reports on how to build a machine.

Gunning: Right.

Neff: And then you did it differently.

Gunning: Slightly.

Neff: Just slightly.

Gunning: Yeah. If you were to look at the-- the Princeton machine, I think, had the same kind of registers. And we had roughly the same kind of vacuum tubes. We used the design rules for circuit design that were very, very careful to have reserve capability. But it was still basically an IAS machine. I have some other notes about that.

Neff: Because this is before people knew about software portability, moving software around.

Gunning: Oh yeah.

Neff: So did you want to show some of the hardware features in the machine?

Gunning: Sure, if we can do that. It's hard to get at it. But the-- well you run tours about pointing out what's in this register and so on, don't you?

Neff: Hardly.

Gunning: Hardly? Well, okay.

Neff: Because we only spend a couple of minutes on this machine.

Gunning: Okay. Go ahead.

Neff: Go ahead, it's your machine.

Gunning: Well, starting with this machine, in the basement at the Rand Corporation is a big-- was, I don't think it's there anymore. Was a big IBM going the length of the machine and that had distributed transformers that ran wires up the columns to supply the heater portage. And it was spread out in order to be sure that you could isolate heater cathode leakage. And somewhere-- well, I guess it's gone. There was a big variac, that's a thing that…

Neff: Yeah. Changes voltage.

Gunning: … changes voltage.

Neff: Adjusts the voltage.

Gunning: And it was motor driven, and anytime you turned the machine on or turned it off, it would slowly change that voltage. And the reason was that the cathode-- and the cathode rate, and mean in the tubes that are in this machine, there's a sleeve which is the cathode, and inside of that sleeve is the heater, heater wires. And if you turn it on smash, the heater expands rapidly and the cathode is on the outside, is sliding inside of the tube. And that's the way you wear it out. And so going either way, you want to make that go slowly. And then you want to be able to find out what the status of the heater cathode leakage is. It would be nice if it were a real insulator, but the-- also on this end of the machine are a lot of meters that are keeping track of the voltages that are on the various registers. And, I don't remember exactly how it worked, but I think maybe there's a sensor that has 12 spots on it, got to it. The transformers were-- each bay had a set of heater transformers along the bottom.

Neff: Looks like they're gone.

Gunning: I think they were lost before the machine got to-- anyway the idea was you were able to get at the heater in groups of 12. So there were transformers here, and they would come up in supply lines to run the heater, to supply the heater voltage. And then run the length of the machine down underneath it to get the way to measure that heater cathode leakage. Because if it gets to be a little bad, you want to get that one out.

Neff: So you're doing like one set of tubes at a time because you're doing it in a crossways?

Gunning: Exactly.

Neff: Okay. So it's not to an individual tube, but it's like to one set of…

Gunning: Oh that would be thousands of links.

Neff: Yeah. I know. It looks like a dozen tubes?

Gunning: I think that's right. Yeah.

Neff: Per ship. Okay.

Gunning: Let's see now, what else did I have?

Neff: So the next question is, what was the mean time to failure on this machine? How much time did it work, and how much time were you fixing it?

Gunning: That's a good question and the thing that's being copied has some information about that.

Neff: Okay.

Gunning: It was very successful. It did better then the IBM 701.

Neff: Is that in the original form with the Selectron tubes, or later with the <inaudible>.

Gunning: Yeah. I think with the Selectron tubes. We can get into that, that's a very interesting thing.

Neff: Okay. Because normally you think of vacuum tubes as being very unreliable.

Gunning: Yeah. And I guess all you can say is that if you coddle them; they'll do pretty well. And you run them lower then the rating, but not too low because that does some electro-chemical deterioration on the heater cathode stuff.

Neff: So you want to talk about the Selectron?

Gunning: Okay. Why did we consider the Selectron? Well it depends on what the competition was.

Neff: So this is a Selectron tube, and this was the memory element that was used in the original version of the Johnniac, and later on it was replaces with core memory. And so you want to tell us about it?

Gunning: Okay. Well the competition for memory, high speed parallel memory, was the Selectron tube and this has digital selection of the cell site. Like core, but core wasn't available yet. The other high speed parallel about the order of a thousand bits, was the so called Williams tube. And the selection of the story space was analog. And you'd sign a beam down and make it land in the face of the tube and the electrons would puff up out of this and fold down and make a little electrical signal.

Neff: Yeah. It's a CRT tube.

Gunning: It's a CRT tube, right.

Neff: Like in television sets.

Gunning: Yeah. Except that they were about this-- the screen is about this big. And they were noisy and you had to adjust the position of each of the thousand spots to avoid defects that were inevitably present in tubes. And you'd go through and try to find them. Instead of that, the Selectron, this little area here I guess, is that just 8 by 8? I forget how many. But when you made a selection, it would pick one of these cells and discharge it, and then pass the signal through the coaxial connector down here at the base, making it possible to get good signal through the interconnect. So that was attractive. Another thing was that we had inside information from RCA about how this thing will work because George Brown, who was one of the three of us who had surveyed the industry, was a patent holder, amongst others, on the Selectron. So that was-- it gave us the chance to have a digitally selected parallel memory.

Neff: Okay. So one tube was how many bits?

Gunning: What's the power of 2 that starts with 4?

Neff: 4,096.

Gunning: No. 400 and something. 256 x 2.

Neff: That's 512.

Gunning: It's 512.

Neff: Bits?

Gunning: I think. Maybe it's only 256.

Neff: And there were how many tubes in the machine?

Gunning: The registers are 40 bits long. So the memory has to be…

Neff: Something times 40.

Gunning: Yeah. And-- yeah, each tube is one of those 40 bits. And so we had started off with only 256 I guess. No, wait a minute, we had 32 memory tubes. And there were sockets for 256-- there were 2 times 40 when it was fully implemented.

Neff: Okay. And you used this for a year or two?

Gunning: Yeah. Let's see. One of the things that we knew, we learned from RCA, was that they were going to stop with the Selectron because they could see magnetic coils around the corner or down the street. And so we did so at Rand, but since we had this inside track through George Brown, we decided to work with RCA and make a Selectron memory, and did so. It was the only one I guess that ever made it to the machine status. The Williams tube was a very sensitive thing. The IBM 701 had-- they had done a very good job of designing a tube that would work in this analog state, but if you flashed the switcher on the lights in the room where the computer was, you were probably going to get a bit error. They were fragile electrically. And so the fact that you could count on getting a bit from the one that you wanted was what got to us. And each of those tubes cost in the order of $400 or $500. That's something I got off of the web. I don't know for sure if that's true, but it seems reasonable to me that that's what it would cost.

Neff: Yeah. There's an immense amount of stuff in this too.

Gunning: There certainly is. And when we had it running in the machine, we had sitting on the side next to that end of the machine, about three or four of those tubes. Because they'd develop noise. They'd develop bad spots. And so a way you could fix that, and we learned this from RCA because they did it on their production line, was to use a 1000 volt discharge on the outside of the glass tube and it would spark into there and sometimes fix it. And so we-- that's the way it was living with the Selectron.

Neff: So you weren't using parody or any error checking or anything like that with this?

Gunning: Oh sure. In fact in both this and the core memory, there is built in memory test. You can go into memory test to find out which bit was-- were all the bits right. You know, a hardware bit memory test.

Neff: Okay. So the machine that was afraid of the dark.

Gunning: Okay. Well, let me add one thing. Another reason that we decided to go that way is that I had a chance to work at SWAC [Standard Western Automatic Computer] which was developing Williams tube memory at UCLA, I was there three days a week. And that was part of the input that we got for the condition of…

Neff: Williams tube.

Gunning: Yeah. Of Williams Tubes. Okay, and afraid of the dark. The register here allowed you to get at every bit in the machine. And since they are physically far apart, the wires were kind of long, and this was a serious mistake on my part. We saved the signal by running it through a neon which would allow it to stand of in the order of 75 volts, I think it was. But the threshold depends on how many photons there are coming in. And when you turn the light off, it would be a different circuit basically.

Neff: Okay. So these are the little orange glowing neon tubes.

Gunning: Yeah.

Neff: And so there was one for each bit of the registers.

Gunning: Right.

Neff: So you could sit at the front and read out the internal registers in the machine just from all the neon lights.

Gunning: Exactly. You got it.

Neff: Okay. But since it's a glowing device it's depends on the quality of the neon gas inside.

Gunning: Yeah, that's right. And we just had to redo that circuit, move the neon tubes to another part of it I think. But it was a subtle thing because it would be-- possible a different bent that was filed up. Or different time. It was hard to diagnose. But it got diagnosed and didn't cause any trouble after that.

Neff: So did you just leave the lights on in the room?

Gunning: No. My recollection is that the repair was such that the lights didn't affect it. It worked properly.

Neff: All the time?

Gunning: All the time.

Neff: Okay.

Gunning: Now, I think that's right. Willis Ware would know. He's was one of the people from the Institute for Advanced Study, IAS, where the von Neumann machine was, that joined us in building this machine.

Neff: It would be interesting to find out why he left.

Gunning: Well I wonder. Julian Bigelow was the name of the guy who really set things up for the electrical circuits for the Princeton machine. And Julian was a very sound, cautious, capable designer. And Willis, I think as part of his PhD thesis, documented the philosophy of design that went into this machine and made it work as well as it did.

Neff: Okay. I'll have to look for that. So what else did you do at the Rand Corporation?

Gunning: Well, let's see.

Neff: Or what else is on your list?

Gunning: I might do the MIT in the early days of the magnetic core, and one of the things that we learned was that there was one company that could make the cores, and that every once in a while-- and they were the only source that was available. Except maybe an RCA on a research basis. But those things were-- there was a certain amount of magic in them. So the core memory was Willis and I wrote the specifications for the core memory. And there were six responders and they had to, I mean, they were required to essentially follow Julian Bigelow's design rules. And it made a very good memory. I left about that time.

Neff: Okay. So did the core memory design like vacuum tube electronics around the core to drive it? Or did Rand Corporation built that? I mean, you've got the cores on the wires, right?

Gunning: And the circuits.

Neff: And all the circuits.

Gunning: And the circuits had to have very carefully thought out rules for how the circuits were arrayed.

Neff: So it was a subsystem.

Gunning: Yes. I just remembered another one. During the building of the register we tested every single resister, and there were three or four of them in each cell of each bit. Each cell-- all of the resisters in the circuits. And they were clamped, measured the resistance and put torque on the resister and this would show any of them that had an internal factor. And we learned that from the resister company. And it paid off, I'm sure, in terms of reliability. What all that was about, was just that it was the kind of things that you don't ordinarily find in designs in those days.

Neff: Yes, because normally you don't think of resisters as something that breaks. But they do.

Gunning: Well it's broken. And then while we were trying-- I mean the tube, if had a resister, it's a cylinder of stuff, and if you twist it a little bit, it will still have conductivity across the fracture.

Neff: I see. So do you know what sort of computers were being used at Rand when they turned off the Johnniac? I mean, what sort of-- well, I assume they bought computers along with Johnniac later.

Gunning: Right. The 701 number 11, as I remember, was there somewhere in the early days of the Johnniac.

Neff: With the Williams tubes.

Gunning: Yeah.

Neff: Did you get a 704?

Gunning: Oh yeah. They just kept going.

Neff: They just kept buying them.

Gunning: Right. Well I guess in those days you could lease them.

Neff: Okay. So what else is in your list? Where did you go after the Rand Corporation?

Gunning: I went out into Orange County and worked at Beckman Instruments on data acquisition systems, which is something that I'd done some of before. And then formed a group called Astrodata, and that's what that little thing was, that you made a copy.

Neff: Okay. So this is your magazine, newsletter?

Gunning: Yeah.

Neff: Okay.

Gunning: It was a write-- it was something that Willis wrote about the turning off of the-- this is in 1966.

Neff: 1966?

Gunning: 1956.

Neff: 1956. Okay. Any other comments about the Johnniac?

Gunning: Well, I liked working on it. I guess not, unless there's something you want to pursue?

Neff: Were you involved in the typewriter interface?

Gunning: Yeah. And the punch card-- there was a-- it read punch cards as input.

Neff: And punched.

Gunning: And punched.

Neff: And this bizarre line printer over here. I've never seen a line printer like that.

Gunning: Oh that one. Yeah. It's a whirling font and hammers, isn't it?

Neff: Yeah.

Gunning: Yeah, those were things that you just-- what everybody-- all the computer users were used to was getting allotted a certain amount of time, and when their time started they had their deck of cards and they'd put them in. And so that's what this would do, except faster. The Rand guys had developed some ways of having some computing going on, on the wires at the interface of the patch board. The IBM machines had a place where you could put IBM cards. Then they could change the way they-- what they did.

Neff: This is an IBM accounting machine?

Gunning: Yeah.

Neff: Okay. And you used one of those to attach?

Gunning: They used some kind of computer that would attach into the IBM patch board circuits.

Neff: Oh. Okay.

Gunning: They were really doing a lot of computing. And these were stressful times.

Neff: Yeah. That's why they built the SAGE [Semi Automatic Ground Environment] Air Defense System. Because it was a stressful time.

Gunning: Yes. Isn't SAGE the thing that became the-- yeah. Didn't it become the model for the airplane?

Neff: Yeah. The FAA track, yeah.

Gunning: Yeah.

Neff: It was the model for that.

Gunning: That was at a different Santa Monica location.

Neff: What company was that? I can't remember.

Gunning: I don't know.

Neff: It wasn't RAND, it was somebody else.

Gunning: Yes, it was formed out of RAND I think.

Neff: The group that programmed the SAGE was…

Gunning: Yeah. I don't-- they were involved and I can't remember how exactly how it worked. Partly because of the security. And I was down in the nitty gritty nuts and bolts and broken resisters.

Neff: So, anything else?

Gunning: I don’t think so. I have very little to say about software, because I was a hardware nut.

Neff: Oh, that’s fine. Okay, well thank you very much for coming and talking to us about Johnniac. I feel it’s one of our star attractions because it’s unique. And I find it very interesting that we have a small number of very unique items here at the museum. So I want to thank you very much for doing this interview.

Bill Gunning: Okay.

END OF INTERVIEW

