Computer Oral History Collection, 1969-1973, 1977

Interviewees: Henry Herold and Jack Mitchell
Interviewer: Robina Mapstone
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MAPSTONE:

The date is April tenth 1973. This is Bobbi Mapstone, I'm talking with Henry Herold and Jack Mitchell, and this is an interview for the Smithsonian Computer History Project. Henry, I'd like you to talk about your education just briefly, where you went to school, your teaching, events that led up to your getting until Logistics Research.

HEROLD:

I went to high school at Glendale High, which is right here near Los Angeles. I first went to college at Berkeley and I was on the V-12 program and studied physics. The war was beginning at that time and I got in the tail end of the war and was out at sea for a year and a half. Then I came back and went to Cal Tech, where I studied geophysics and thought I might get into the oil business. I spent one summer working in the oil business and found that I didn't like being out in the sticks that much. So then I went to Paris for a year. I thought I'd have fun, so I went and enjoyed myself in France, studying French and just playing mostly, and traveling around Europe. Then I came back and was offered a job teaching engineering at a small school in Los Angeles. The school was called West Coast University, and the guy in charge, Victor L. Connan, was very, very intelligent man and he gave me good assignments. I stayed there four years, teaching all kind of mathematical physics, machines, engineering, electrical engineering, thermodynamics. By teaching, I really got a theoretical, theoretical ability that I never would have anyplace else. I think by the time I left there I had was very good in solving academic kinds of questions in most fields. But I had taught pretty much the whole curriculum, including many graduate courses at that place, and the school wasn't really going anyplace and I knew I didn't want to stay there forever. And I had some friends who were getting involved in a crazy company called Logistics Research. Among them was Al Hook, who had been a friend of my--his mother was a friend of my mother, so I knew him since childhood.

MITCHELL:

A former captain or something?

HEROLD:

He was a captain.

MAPSTONE & MITCHELL:

Captain Hook! [laughter]

HEROLD:

No, no, not the same guy, no. No, I'd known Al Hook for a long time, and somehow I'd gotten in touch with him again. I didn't see him very often, but he mentioned that he was working for a guy named Glen Hagen, and that they were starting this company, Logistics Research. And I guess it had already been going about six or eight months before I approached them. And they were getting fantastic pay for those days, and they also had come as a group pretty much, I think, from Northrop, having built the [?]. They didn't know what they were going to do. They'd got all this money from Wenner-Gren, and so hey were. . . It was unsettled what the company was for. [laughter] I went down there, and they were just really playing around, having fun, and dreaming up all kinds of crazy ideas. Glenn Hagen, as you know, had many strange projects in mind.

MAPSTONE:

Wasn't the main shot to try and computerize the railroad systems in some way?

HEROLD:

Well, he was going to leave messages on the railroad tracks for trains. That was one scheme. Some of these schemes eventually worked out in different ways from the original idea. They became practical, not through him, but later, I think. Now the Bart system does use the tracks for some sort of communication. He also wanted to build a great big robot in which the operator would be in the brain of this robot, or the head of this robot, and whatever the operator did, though, the great math monster would do. And what else did he have? He was going to build an enormous storage, a rotating drum, I think, a huge drum for a mass storage, digital storage. That was another scheme he had.

MAPSTONE:

You did build that drum, didn't you?

HEROLD:

Well, I don't know. I think there was some work done on it. But I don't think it was ever very operable. I think that . . .

MITCHELL:

They had a great ideas for the time, the head with the ear that came out of the center of the head, which. . .

HEROLD:

It was going to be floating, right.

MITCHELL:

The Verduli effect, right. Floating heads.

HEROLD:

There was some other schemes. Well, we were just fooling around. We had a lot of fun just playing. I can mention some of the people that were there. Allen Beek, of course, and that's where I met Allen. And he and I got along very well. And he'd already, he already knew Al Hook. And Al Sharon was there as well. He's now a software guy, I think, up in Palo Alto somewhere. Now who else was there? Glenn Hagen, who was the manager of the company, who was the most ridiculous, outrageous, funniest guy that you'd ever went to know! And Vince Neisius, and of course C.I. Russell was there, Dick Russell.

MAPSTONE:

Where did Charlie Williams fit in?

HEROLD:

Charlie Williams was there, but I didn't know Charlie very well. I never got very close to him. It was a strange thing. I somehow . . . I was very junior at the time, and I think he was further up the organization. And I think he was there. I'm not sure. But at any rate, I never knew him. I can't, I just don't remember me having much contact with him. Well, it wasn't long before we were going to do a computer. It just seemed like that was in the back of everybody's head that was there. Of course, I'd never been through a computer before, so I was a very junior engineer. But we designed a drum memory tube computer. I think the flop rate was something like sixty-seven k, something like that, thirty-three bits per word or some crazy number. I don't remember. It was thirty-six. And we had a stepping switch for selecting the heads on the drum. We had a stepping switch. This was for the main memory. It was just a telephone type stepping switch, and we were actually switching the head signals directly without any amplification at all. The stepping switch was exposed completely and so often it would not pick up the information. And we'd just get the stepping switch and just go around and around, seeking the correct tracks when the track number was read right off the drum itself. And so you'd just keep going around and around. And I remember, after we got the machine going. we took it up to San Francisco on an early computer conference. I think it was

one of the very first actual computers that was displayed in a conference and that was actually running. But it wasn't running most of the time because we used to just sit there with rags soaked in carbon tetrachloride and slap that stuff in the switch! [laughter] It was just a constant thing! That crazy little program that we had made up. It was, you know, it was just like a huge deck of, house of cards--it would all collapse very often. But it did work from time to time.

MAPSTONE:

Did anyone want to buy this presently?

HEROLD:

I think we sold a few. I don't think we sold very many. It was mostly Wenner-Gren's money that backed it almost entirely. I'm sure that we did the thing while the company was spending money. The idea was, I guess, research of some sort. I don't know why Wenner-Gren backed this thing. Nobody can really understand Wenner-Gren, but Hagen seemed to have him under control. Finally, I guess you heard that the--Well, Dick Russell had a big outing with Glenn Hagen, and I sort of was allied to Dick Russell. So about half the company had this big management revolt, and I felt that I was obliged to leave when the people that I was more or less associated forces with. So we all left, and in a big huff. And I think I stayed there less than two years, from 1952, when I came, somewhere around the summertime--August, I think--August, '52. And I think I had left by late '53.

MAPSTONE:

Did--this was . . . You called it the ALWAC, I guess?

HEROLD:

Well, no. Now what did we call it? Maybe we did call it the ALWAC I or IA or something like that. The ALWAC. But the name of the company was not ALWAC. It was still Logistics Research when I left. ALWAC stood for Axel Wenner-Gren.

MAPSTONE:

Was it just a sort of state of the art machine then, and it didn't

HEROLD:

Well, I didn't really know if it was the state of the art. It was hard for me to tell.

MITCHELL:

Well, the state of the art was pretty dim in those days. [laughter] Anything was up to the state of the art.

HEROLD:

I don't know. the 650, the IRM 650 computer, a gov machine, did not come out until after this one did, but I think it was a lot better machine. This one was . . . Well, it wasn't way behind, but it had many examined flaws in it. It wasn't, I don't think it was terribly commercial. But no machines really ran very well through those days. It was all tubes, except for the [?] crystal diodes. They cost about a dollar a piece. Can you imagine? Sixty-seven Kilocycles or something. You know, on the main memory was a drum axis so you'd know the length of it to come around, and then if you wanted to go to main memory, you'd have to wait for that stepping switch, which was seconds later. It was horrible. You would hardly believe it.

MITCHELL:

Especially when it wouldn't stop.

HEROLD:

Right! [laughter]

MITCHELL:

Especially when [?].

HEROLD:

Right! I think on the later model before I left we actually put in a rely selecting network, which was a lot faster. But still it wasn't very good.

MITCHELL:

That was a J.B. Rea?

HEROLD:

Oh, was that?

MITCHELL:

Yeah, a J.B. Rea.

HEROLD:

J.B. Rea. It was forever. It was just like whom-boom and everything was so hard. I don't remember much about the control panels. We had the typewriter, reflexor IRM. What else did we have on it? We may have had carburetor on too. I don't think very much peripheral equipment. But no tape. They were talking about magnetic tape, but don't think they ever got around to it, at least while I was there.

MITCHELL:

Was there no display or anything like that?

HEROLD:

No. There wasn't. I don't think displays were very common than.

MITCHELL:

We had them earlier.

HEROLD:

Did we?

MITCHELL:

With the scope there. Don't you remember? With the . . .

HEROLD:

Oh, you mean just with a scope showing signals?

MITCHELL:

You could read the numbers.

HEROLD:

Same as with the switch?

MITCHELL:

Yeah. You read the numbers.

HEROLD:

Yeah, I guess we had that. Of course we had that when he had, you know, when we reversed the sweep on the scopes so you could read significant data input to the right, and you could read the numbers by this, reading one's and zero's.

MAPSTONE:

And it was programmable?

HEROLD:

On, yeah, it was a sort of program machine! Sure. Oh, yes. It was programmable. But to solve it was really [?]. And then it was just a pile of junk sort of thing compared to what you find now. It just would run for awhile, run for a few days, and then it would be all be done for.

MAPSTONE:

Do you remember who were some of the people who actually bought it?

HEROLD:

No. No. I don't think they sold very many of the first ones. I don't remember.

MAPSTONE:

How many ALWACs were there? I mean, you know, sort of later models.

HEROLD:

Well, I left before there were more, but Al Dix should know. I know that from the I they went to the II, and then to the 3, I guess the 3-E which sold good.

MAPSTONE:

3-E.

HEROLD:

3-A, they sold a lot of them. But this was the one. And it was almost primitive. There was very few made. I think maybe one or two models that I knew of would be made. And I guess we sold them.

MITCHELL:

Poor devils! [laughter]

HEROLD:

I guess they really wanted to play with it. It was modular in design. You know, we had standard modules, flip flops. I don't think we even had etched back boards, etched boards, for--I don't think there were just any boards. Two vacuum tubes on a card, and then I think we used the blue ribbon connectors, and diodes, both heads were all diodes.

MITCHELL:

You're still talking about the [?] machine. Is it the same kind of…

HEROLD:

Yes, I think it had the same kind of thing pretty much. Right.

MAPSTONE:

Export?

HEROLD:

Oh, yes, for export.

MAPSTONE:

Had the [?]fixed, or floating by this time?

HEROLD:

No, nobody hardly thought about floating decimal.

MITCHELL:

It was hard enough to get anything working.

HEROLD:

I think I'm pretty sure we had multiply in there. We did. We multiplied by just adding [?].

MAPSTONE:

Was Logistics Research--I guess it was--a Boolean algebra design rather than the flow charts?

HEROLD:

Flow charts or diagrams? Definitely. I think we started using the type of thing which ran along the side of the equation so you could use the logic directly as you watched the machine, be able to find ten numbers on the equations without any drum logic whatsoever. I think we started that scheme.

MAPSTONE:

I see. (pause) Jack, maybe this is a good time to pick up on you now.

MITCHELL:

All right.

MAPSTONE:

And get your beginnings.

MITCHELL:

Well, I started as a photographer.

MAPSTONE:

Oh! Talk to you.

MITCHELL:

I graduated out from the--once I got out here. That is, I was born and raised in New England, and after the war came out here, went to the Art Center School and graduated from there, the Art Center School of Photography here in Los Angeles, and wanted to stay in Los Angeles. A lot of my friends from that school moved out and became successful photographers in other cities. But in Los Angeles the field was so packed that I was starving to death. And in the Army I had been in another program similar to Henry's V-12. I was in the Army's specialized training program and had taken engineering. I decided to go back to school, forced by the pains of hunger; and having already many units in engineering, I decided--and also liking engineering--to go back to school in engineering. I graduated from UCLA in Engineering.

MAPSTONE:

When was it?

MITCHELL:

In 1954. While I was at school I decided to go into computer business. I thought that computers were rather fascinating and that they also were something that boded good for the future--my future, anyway.

MAPSTONE:

Where you familiar with SWAC and the work that was going on at UCLA?

MITCHELL:

I was familiar with SWAC. I never went over there. But I had to work when I was going to school and I, fortunately, had a very good part-time job doing some initially installing sound systems, paging systems, private telephone systems. They liked me at this company where I worked and each semester when I got my new schedule, we would merge the two schedules so that I would eat my lunch in the car racing from UCLA down to the job. [laughter] And work as many hours as I possibly could. My wife was also working at that time. She put me through school. I'm now putting her through law school.

MAPSTONE:

That seems like a fair exchange.

MITCHELL:

Right.

MAPSTONE:

But so you say that you thought about computers being the way of the future. What was your . . . You know. What was your knowledge of them or how did you learn?

MITCHELL:

Well, at UCLA they were just starting some courses in computer design. Willis Ware was teaching a class, and . . .

MAPSTONE:

Monte Phister.

MITCHELL:

Yes, Monte Phister had a class only--There were . . . Most of the computer courses were extension courses. They were graduate courses. And at UCLA one was permitted to s elect a certain number of hours in whatever, an elective field, which was your main source of study. And since I wanted to get into computers, most of my classes in my final two semesters there were at night taking graduate courses as an undergraduate. In any event, they had interviews at that school for graduating students. I was interviewed by a guy whose name was J.M. Mitchell. [laughter]

MAPSTONE:

[laughter] A real J. Mitchell?

HEROLD:

[?] before. We both knew him.

MITCHELL:

Fortunately, his first name was James. And he worked for the J. B. Rea Company. He suggested that I go over there and talk to Dick, Russell, who had just gotten there himself. I did, and Dick offered me a job, which I accepted, as a junior engineer. I started designing some flip flop circuits there, and we were just starting on the Radix at that time. Henry was involved in the design of the logical equations, and Russell himself, I guess, was really doing most of the project engineering for the thing.

MAPSTONE:

How did J.B. Rae get into, you know, what led up to the company going into computer's?

MITCHELL:

I don't know. Someone must have talked him into it.

HEROLD:

Well . . .

MAPSTONE:

Do you know?

HEROLD:

Yeah, well, Dick and I and I think there was maybe somebody else-

MITCHELL:

Lloyd Shoemacker.

HEROLD:

Lou [?] , Lloyd Shoemacker, we were all had left Logistics Research and were unemployed. So we approached J. B. Rea as a group. We came in and had a big meeting with him. J. B. Rea was sort of a swinging type of entrepreneur, interested in engineering, and I think he saw the possibilities in computers. It turns out he lost his shirt. He was interested in getting into it, and I think it was just his money to develop this [?].

MITCHELL:I

It was his father-in-law's money.

HEROLD:

Father-in-law, I think, right. His father-in-law's money.

MAPSTONE:

Up to that point, what had been the kinds of things they were doing?

HEROLD:

They were doing smaller things, primarily in the analog field.

MITCHELL:

Well, they weren't making any products. They were mostly consulting and engineering company, and they were doing research studies and engineering studies for various arms of the government.

HEROLD:

Yes, the first few months I worked there they did not start a computer. I worked on a big analog system, which was educational to me, working out trajectories, I think it was, under contract to the Air Force or something like that.

MITCHELL:

They had an analog computer there, and they also had . . .

MAPSTONE:

They had the [?]

HEROLD:

No, this was Beckman. Beckman Analog Computer, the big one.

MITCHELL:

They also had the digital computer there, which was a—

HEROLD:

A CPC.

MITCHELL:

CPC, which they used to pack dry ice around the bottom of that thing, in the summertime, I remember, to keep it going. [laughter] Periodically some-one would have to dash out for another load of dry ice. On those hot days it would just come up with the wildest answers.

MAPSTONE:

So really J. B. Rea, the company, was not building any hardware or parts of any kind.

HEROLD:

No, not digital work. No, really not. Nothing digital. They didn't really build--very little when we first started.

MITCHELL:

Well, they started about the same time as we did on the computer with an analog to digital converter, which was a vacuum tube thing.

HEROLD:

Right.

MITCHELL:

Which was known as the Rea converter, everything in the company being the Rea-something. [laughter] There were two guys working on that.

HEROLD:

It was a bunch of little small projects.

MITCHELL:

But that was the only other product that had at that time.

HEROLD:

As a matter of fact, the digital people, like you and I and Dick and those people, we never really mixed much with the ones who had been there from way back, who stayed pretty much doing their smaller projects, and the analog type things that [?]. It was a very strange non-cohesive company in that there were really little cliques. As a matter of fact, the tiny clique who formed the group doing the converting work, and our group, which was really sort of allied in that we were both at least of their device in doing digital work, we were more competitive than cooperative. They used different flip flop circuits than we did completely' everything was different.

MAPSTONE:

The HRH syndrome, huh? Each one of you all had to develop your own things, regardless of somebody else had done something that you could have used?

MITCHELL:

I suppose. I'm not sure. We all, of course, each felt that our system was far, far superior to the others.

MAPSTONE:

Naturally. (phone rings; interruption in interview)

HEROLD:

And so we didn't start building a computer right away. I guess we had started by the time you come to the place. I was working on analog, that big analog monstrous thing on trajectories, which I thought was really the output was just nonsense, absolute nonsense, by the time you'd run those things through all those amplifiers and [?] and grade circuits. And I thought it was absolutely meaningless, just a squiggle in the output and then nothing.

MITCHELL:

It must have meant something to somebody. Somebody paid for it! [laughter]

MAPSTONE:

So the computer that Rea finally started to build was not contracted by anybody.

MITCHELL:

No, there was.

HEROLD:

I think it was in the military. There was someone in the Navy but I'm not sure whether we built that thing up for the Navy or . . .

MITCHELL:

I don't know when that was. We were really doing it in parallel we were really building the same computer in two forms. One of them was the computer, Raedix more or less, which was going to go into a submarine. And there was the problem of fitting the thing into the submarine hatch. And so it had to be foldable. . .

HEROLD:

Foldable into some sort of shape that would go around the hatch of the submarine.

HEROLD:

As it ultimately turned out thing would up submarine. I understand they showed it off the end of a dock side. [laughter] So finally it did get under-water! Submarine, of course! It didn't work down there, though.

MITCHELL:

There were interesting problems, though. That was supposed to be a tracking system computer, wasn't it? It was going to track other submarines, I believe. Or, no, sort of a, it was a target simulator or something like that.

MITCHELL:

I don't know what the purpose was.

HEROLD:

Oh, I remember getting into the mathematics of that one. Very interesting.

MITCHELL:

There was some money which came in from that contract.

HEROLD:

And then they sold one to Wright Air Force Field. That was the regular standard.

MAPSTONE:

That was a standard g.p. Now the one that was planned for the submarine, apart from its configurations and shape—

MITCHELL:

It used the same logic. It was supposed to have the same programming and identical otherwise, and the same control panel.

MITCHELL:

The only thing different was the packaging.

HEROLD:

Right.

MITCHELL:

Of course, at that point we started at, nothing had been packaged anyway. So most of the work really went into the commercial design. And then I don't know, there was someone else who mostly was a mechanical designer who worked on that aspect of the things, on how to package what we were building into something we could get down the hatch. That was the only problem. There was no problem of spacing in the submarine, as I under-stand it, it was just how to get the damn thing in the submarine through that hole!

HEROLD:

Right!

MAPSTONE:

You could have gone down and built it in the submarine.

MITCHELL:

Well, it would have been just about as easy as the commercial one, which we went out to

date and then we built anyway.

HEROLD:

No, it would have been a little worse to climb through by the time we brought that thing out

MAPSTONE:

You've sort of already some work with the ALWAC.

HEROLD:

Yes, so I had the general idea, and the machine was modeled somewhat after the ALWAC l, I would say, but it was decimal. What else about it? It was a little faster. A hundred kc then--was it a hundred kc?

MITCHELL:

Yes. It was a hundred kc and it used relay tree for selecting the heads from the drum.

HEROLD:

A relay tree for selecting the heads. Again un-amplified.

MITCHELL:

Yes, again un-amplified, with one amplifier.

HEROLD:

Right. And it was modular packaging.

MAPSTONE:

Were there all kinds of problems with it? You know.

MITCHELL:

Oh, yes. [laughter] Oh, yes!

MAPSTONE:

Why did you not use amplification?

MITCHELL:

Well, it was too expensive, because then you needed an amplifier for each head, and we had something like in excess of a hundred heads on the drum.

MAPSTONE:

Oh, I see.

MITCHELL:

And of course, in those days one couldn't just go out and buy a drum and go out and buy a head. One could build only one's own. . .

HEROLD:

We're leading into the story about foot [?].

MAPSTONE:

One did?

MITCHELL:

You had to build everything yourself.

MAPSTONE:

But some were. I mean, for instance, couldn't you have bought a drum from ERA?

HEROLD:

Oh, I don't think so. Especially not economically.

MAPSTONE:

Oh.

MITCHELL:

We had to produce everything. We bought the vacuum tubes, but that was about it.

HEROLD:

Well, the diodes.

MITCHELL:

And the diodes.

HEROLD:

What did you put on them? We put them on a board. We had etched boards, didn't we?

MITCHELL:

No, we had no etched boards.

HEROLD:

No etched boards?

MITCHELL:

No, just at the time the company was going down the drain, we started working on etched boards to cut some of the wiring costs. But that never really came to fruition. All those boards were hand-wired. There were two flip-flops on a module with a dual triode for each flip-flop. It got pretty hot.

HEROLD:

We got two flip-flops in one tube, or one?

MITCHELL:

One flip-flop per tube. Oh, you needed two triodes [?].

HEROLD:

You needed twin triodes plus [?]. Right. Got it.

MITCHELL:

So there you had two flip-flops per card, one flip-flop per tube. And we had two types of flip-flops. And we had really . . .

HEROLD:

. . . high voltage running all over the machine. High? Something like three hundred and fifty volts in one power bust, was it? Or more. We had 120?

MITCHELL:

More. We had more. I think it was four hundred and something in the amplifier for the memory circuit. And that's the story I told you about, Dick Russell coming upon me while I was working on that circuit, and pounding against the side of the computer, causing me to leap twenty feet backwards. [laughter] But I did get even with him.

HEROLD:

Doing the same thing.

MITCHELL:

Several years later. [laughter] I mean the same thing! Pow! I hit it.

HEROLD:

What was the voltage signals, I mean the logic signals? About twenty volts or twenty-five volts, something like that?

MITCHELL:

Yes. We had them clamped at plus-twenty-volts.

HEROLD:

And ground.

MITCHELL:

And ground, right. But of course we had a high voltage for the vacuum tube, [?] voltages. I don't think we had much problems in levels of logic. And we had, let's see, with a hundred kc we had ten megaseconds for each. I guess we did anything we wanted.

MITCHELL:

Oh, no, we didn't do anything we wanted. We had trouble with timing.

HEROLD:

Did we?

MITCHELL:

Sure.

HEROLD:

I know one thing we had trouble with was the . . .

MITCHELL:

The circuits were really slow. You're thinking in terms of modern day times.

HEROLD:

Yes, I know. I know they were slow, but we had plenty of time, too. One thing we had trouble with and that was the resistor values. Gosh, I remember we used to have to add tack-on resistors all the time, because you'd change the value of the pole, and you'd have to change the pole down or, because we went through and/or, and/or, without going through that, that was difficult! [laughter]

MITCHELL:

That was true throughout the industry. Everybody did . . .

HEROLD:

And/or circuitry—

MITCHELL:

[?].

HEROLD:

By resisting the diodes for the ors and a resistor to a negative supply. But then what that or ran into an and, you had to balance the up resistor for the and with the down resistor for the or.

HEROLD:

[laughter] You had to pull the down up!

MITCHELL:

And then if you multiplied these things and went from an or to an and, from an or to an and, you know, the balancing of those resistors was a terribly delicate operation.

HEROLD:

Then you'd pull another signal coming into the same and, which had a very [?] resistor, and you'd have to switch all kinds of current.

MITCHELL:

We wound up having a huge terminal board on the back of the computer just loaded with resistors, which we would change every week. Oh, boy! We'd patch another resistor on in parallel and then another, and finally these things of their own eight would start to [?], and we just replace them at that point with a single resistor again.

HEROLD:

I could remember huge [?] on the back of that machine where we had all kinds of resistors tied on there temporarily, you know, trying to balance when you pushed the button. It was really a mess! [laughter] But I don't remember any situations where it was the problem of timing, where we didn't get through because we couldn't get the time.

MITCHELL:

As I recall, we did have timing problems on that thing. It seems to me we were doing something in the check bits there.

HEROLD:

Maybe the signals were getting out so slowly because the resistors values would change. You'd just barely get going. . .

MITCHELL:

We went through too many levels of diode logic before we got to the active circuits again. The signals would decay. They just wouldn't rise.

HEROLD:

Did we have any amplifier circuits in the logic? Or did we just simply do it diode logic through the flip-flops? I can't remember. I don't . . . Maybe we had a few buffers. I think some of the big time circuits used big buffers.

MITCHELL:

We must have had.

HEROLD:

Yeah, but they were tube things, so we didn't have very many of them.

MITCHELL:

I don't really remember that circuit, though, so I'm not sure we did.

HEROLD:

We had big blowers going up the sides of the machine where the tubes were. Remember? That would blow all the heat out of those tubes.

MITCHELL:

Well, it was a funny shaped machine. There was a double pedestal, and one pedestal was the drum, and the other one, I think, was . . .

HEROLD:

What was in the other one? Power supply?

MITCHELL:

No, it was the blower. The power supply was a separate unit, as I remember. You should remember that more than anyone!

HEROLD:

I remember that. [laughter]

MITCHELL:

[laughter] But that comes later. But there was a blower in one pedestal and then there was sort of a table top across which was actually an [?], which then blew into the vertical portion of the thing, and which was enclosed by shower doors. We actually had a shower door company come in and install these things. The air would then come up from this blower-pedestal through this duct that went across this whole machine, and then supposedly would blow up through all these modules carrying the heat up through the top. We had a few little problems in there. But it worked moderately well.

HEROLD:

No, the machine, we finally got it so it worked, didn't we, finally, after we worked with it?

MITCHELL:

Finally, after a long, long time.

HEROLD:

Right. It was really miserable.

MAPSTONE:

Tell me about your drum problems.

MITCHELL:

Well, the main problem in the drum was that we had a good mechanical designer who designed a good set of bearings and the proper motor for turning it, and it was a forged billet from which the actual drum itself was turned. But the problem was then of putting a coating on the drum. And I understand that everybody had the same problem. But we, everybody, no one would tell his trade secrets to everyone else, so one started from scratch. I shouldn't say that to refer to it; wrong word; that was the terror of . . .

HEROLD:

[laughter] Don't say scratch!

MITCHELL:

Don't say scratch! But we decided, or someone found out, that you had to cost it with a resinous coating first before spraying an oxide coating over it. So we started experimenting with epoxy glue coatings. We tried every-thing. We brushed it on and we couldn't get it on very evenly. And it also took forever to put layer upon layer of epoxy on. Dick Russell finally had a great idea that we would have a tray full of epoxy glue, and we would then have a motor very slowly rotating the drum, the bottom of which would be dipped in this tray of glue. Then we would have heat lamps shining on the top of it, which would cause it to harden much more rapidly. And it sounded like a great idea to everybody, I must say.

MAPSTONE:

It sounds good now!

MITCHELL:

The only problem is that when epoxy sets up, it sets up almost all at once. In other words, it's a thermal setting material, and when the proper temperature is reached it starts

to harden quite rapidly. And we had it set up so it took a log time to harden actually, and we left. The thing was running, going to run all night to give us a very thick, smooth coating. The only problem was that in the middle of the night sometime, all the epoxy set up, including that in the tray, which was glued to the drum, which was rotated by this motor. [laughter] And the tray came up of course, and hit the heat lamps, which burst, and the housing which held them broke. There were splinters of wood and glass and drum all over!

HEROLD:

[laughter] It was chaos, I'll tell you!

MITCHELL:

All stuck to the drum head, going clankety-clang when we came in the next morning. So we had to saw that off. [laughter] And say, "Now there's got to be a better way." Which I don't believe we ever really found.

HEROLD:

Well, we did have drums that worked. I don't know how they were finally buffered.

MITCHELL:

I think we finally. . . I don't know how we . . .

HEROLD:

You should put it through the tape, the story of the [?].

MAPSTONE:

Yes, that's the other thing.

MITCHELL:

Well, anyhow, this was all turned on the drum. And we never really, at least in the initial years, got a good bond between the epoxy and the aluminum billet, which was the base of the drum. Finally, when we were trying to install the first machine, which had never been properly checked out, and we were in Dayton and various people were running back and forth, it was Howard Carter was back there working on the drum and at one point, the entire coating of the drum came off in one essentially one piece. Howard brought it back and put it on the wall of this huge engineering room we had with a little card which said, Peltus Drummus North Americanus Circa 1955. [laughter]

HEROLD:

And it looked just like an animal;

MITCHELL:

And it looked like this brown, soft coating. It looked like the pelt of an animal.

HEROLD:

It sure was funny! [laughter] What a joke!

MITCHELL:

Everybody thought it was funny except J. B. Rea and his father-in-law, who had a lot of money invested.

HEROLD:

Who kept putting money down the tubes and we kept pouring it out to Dayton. Oh, gosh, and we were struggling with that computer in Dayton. I think. . .

MITCHELL:

Well, the main problem was we had this contract with Patterson in Dayton to, unfortunately they had penalty clauses--they were fairly sophisticated for that period. The guy who ran that company was a great automobile trader, as I recall. He was a very sharp guy, and he had this penalty clause that we had to deliver the computer by a certain date. I don't recall what it was. And, of course, the computer was nowhere near operable, but the date came and the penalty started to accrue and J. B. felt that the proper thing, since the contract said nothing about a working computer, that we would deliver the computer! [laughter] Which we did.

HEROLD:

This was not unique. I think this was common practice.

MITCHELL:

Well, then everybody who was closely associated with getting the machine working, the prototype working—

HEROLD:

MITCHELL:

--went with the prototype to Dayton. And we were living in a hotel for awhile.

HEROLD:

Until we found a boarding-house in Cincinnati.

MITCHELL:

Finally, it took so long--Pardon?

MAPSTONE:

Did you get it running?

HEROLD:

Well, after months. Well, from summertime until—

MITCHELL:

Oh, after a long time we got it running.

HEROLD:

In fact, it was in summer. It was '55. Early in the summer, which was one of the hottest summers they've ever had in Dayton. It was just terrible. the [?] were falling.

MITCHELL:

Well, it wasn't bad in that they had air-conditioned the computer room. [laughter] It certainly made it more worthwhile to go to work in that you wouldn't suffocate from the press of heat. But we went with the machine.

HEROLD:

We went two or three months at a crack, then came back for a breather.

MITCHELL:

Then we worked on the machine there, and at one point we had the huge, enormous parts supply with all these miserable high voltages and with a mag-amp regulated power supply. At one point I was back in Los Angeles and I think Henry and . . .

HEROLD:

Herm Plu.

MITCHELL:

And Herm Plu were there working on this thing, and they had some difficulty with the power supply. And one of them had the bright idea of disconnecting the regulators, at which point all the power supplies went off to some unbelievable value, blowing up every diode in the machine, of which there were some thousands. I don't recall how many. But an awful lot of diodes. And they then were shipping these huge boxes—

HEROLD:

Of the modules, back East.

MITCHELL:

--full of diodes back, and we had some emergency line of people who were replacing them with new diodes.

MAPSTONE:

When you blow a diode, is that?

MITCHELL:

That's it.

MAPSTONE:

When it's finished you have to buy another one at a dollar and somewhat cents.

HEROLD:

That's right.

MITCHELL:

Right. Well, I think by that time they had gotten a little cheaper. They were ninety-something cents.

HEROLD:

Now you seem for partially just like sand. You get them for about six cents.

MITCHELL:

You get them cheaper than resistors now!

HEROLD:

Oh, gosh, a lot cheaper. Nothing now. Real cheap.

MITCHELL:

But anyway, we worked in Dayton for months to get that prototype working. And people used to come down and see how we were doing. Very frequently the commanding general of . . .

HEROLD:

[laughter][?] started out big

MITCHELL:

. . . came down one day, and I was working behind the machine, installing heads in the drum. And Henry was out from doing God knows what when this general walk in, and Henry started showing him the computer and showing him how it was all modular and how we had these dependable modules, and pulled one out of the machine in his own inimitable crunching fashion, at which the blue ribbon connector fell apart in pieces.

HEROLD:

[laughter] It looked like!

MITCHELL:

And the general just nodded his head, and said, "Mmm, yes mmm, very reliable." And I was just rolling on the floor behind the machine. Golly!

MITCHELL:

And I just about passed out from laughter!

HEROLD:

He didn't dare switch his position, he just stayed back there. I should have taken the general back and pointed out Jack Mitchell. "This is one of our designers!" Rolling on the floor with laughter! [laughter]

MAPSTONE:

You know, when you look at how it was, you wonder how anybody, any government agency, any individual, had the stupidity to put money into a computer. I mean . . . And they did it [?].

MITCHELL:

Well, it's really the way the budgetary system of the government operates, in that primarily it's still in operation, that these agencies had so much money budgeted, and they've got to spend that money if they want to maintain the same budget or better for the following. And so between, I guess, the government's fiscal year ends in June, and during the period of Many and June these fantastic sales are made of all kinds of horrible things that people find to spend that money on! And it's money which they have left over, actually. The real fault is in the way, primarily, at that time at least and still, I imagine, the Defense way runs things.

HEROLD:

On the other hand, you can say it was the money that largely built up the computer industry, in this country. That's why we have so much further ahead than Europe, I think, is because this kind of thing was going on, which was wasteful in the usual sense of the word, but it did develop computers.

MAPSTONE:

And for instance, did they get any useful work out of Verdex?

MITCHELL:

As a matter of fact, that agency used that machine, which we did finally get working, for years and years.

MAPSTONE:

Oh, did they?

MITCHELL:

Oh, it was just fantastic!

HEROLD:

Yes. They used it a long time. It really was for years.

MITCHELL:

And even after the company, the J. B. Rea Company, was long gone down the tubes, there were people who were doing maintenance, people who had been doing maintenance people for the Rea Company, who were still maintaining those machines in the field, There were, I think, two of them. Two or three of them.

HEROLD:

I think they were just using them for a special purpose. They had finally got a program they needed and they were just doing that again and again. I don't think they were really programming for it.

MITCHELL:

I don't know, but they still were getting useful work out of the machine.

HEROLD:

They were getting work out of it, yeah, they were using it, definitely. It was used.

MITCHELL:

And so ultimately, I think, they probably got their money's worth. Out of that machine. But it certainly didn't seem like it at the time.

HEROLD:

It was very close to being cancelled, too.

MITCHELL:

And, of course, they—

HEROLD:

Several times, I think, it just about was cancelled.

MITCHELL:

Oh, yeah!

HEROLD:

It was a constant problem stopping them from canceling it, because they got sick of us

clowns here.

MITCHELL:

Of course, the submarine people never got their money's worth.

MAPSTONE:

Yes what I was going to say. What happened to the submarine machine? Was it really junked?

MITCHELL:

That was just, ultimately, that money was used up and it was junked. And that whole thing, as I say, was pushed off into a dock somewhere and went submarine.

HEROLD:

It was a [?] simulator or something they were going to use it for, I think. I've forgotten that [?] .

MITCHELL:

I don't know what the application was.

HEROLD:

But it never did it.

MAPSTONE:

Were there any other. . . Were there just these two machines?

HEROLD:

Well, we had several. We had two or three of them, one back at J. B. Rea there was another machine.

MITCHELL:

And also we had installed one at Dupont. It was a fun place. We went out with that one to Wilmington. And I don't remember which group it was, but it was, but it was more part of the research arm of Dupont. It was a group which developed Teflon. And it was really funny, because when I was installing the machine, these little men would run out of labs with rolls of Teflon wire, saying, "Why don't you try some of this in your machine,

and see how this works!" Which was great for that period, because it was a new high-temperature material. I used to use it all the time to replace wiring if there was anything wrong, because it wouldn't burn if you soldered it, one of these things nobody had at the time.

HEROLD:

Let's see, we had the scope there. We had a Flexowriter that was tied to it directly. And what else did we have? We had mag tape on there. I think it was one k.c.

MITCHELL:

Well, it didn't. . . .

HEROLD:

Work?

MITCHELL:

That tape ultimately worked.

HEROLD:

We had card readers and card punches.

MITCHELL:

Right. That worked.

HEROLD:

They worked, yeah.

MITCHELL:

Herm Plu developed that.

HEROLD:

Herm, yeah. Did the knife tape metal work?

MITCHELL:

Well, ultimately, after I left and went to work for Packard Bell Computer.

HEROLD:

You went and came back as a consultant and got it to go.

MITCHELL:

Howard Carter never got that going and he left before it ever worked. Then, I think it was, Russell hired me back as a consultant to get the mag tapes working. I had to get permission from Max Palevsky to moonlight, which I did, and finally got those tapes going.

HEROLD:

Was it one k.c. or something like that, maybe two? Very slow.

HEROLD:

MITCHELL:

It was one k.c., and it was just a horrible system for a computer to find anything.

HEROLD:

It wasn't compatible; it wasn't compatible with anything.

MITCHELL:

You don't remember how that worked, I suspect, although you had, I think, either you or Mark Goldwater, designed that system. But it was just an awful system logically to work with. Very clever, but impossible to deal with in that there were marker bits in the, if you recall—

HEROLD:

In the bits?

MITCHELL:

We had a forty-four bit word, four bits of which were consisted of the sign, and then there was one check bit to do something or other. Then we used two bits left over. One of those bits then was used as a marker bit in the memory to have to show where the next word collected form the tape would be stored. Then after that was stored, that marker bit would be shifted to the next word. And then after the next one k.c. word came off the drum and was assembled and so on, it would be stored there.

HEROLD:

Oh, boy.

MITCHELL:

Well, the problem was one of looking to see what was happening and trying to synchronize on this thing. Of course, they were synchronized because this bit was jumping all around.

HEROLD:

What did we use for a buffer? There must have been a buffer between the bits, or you didn't have a good memory.

MITCHELL:

Yes. Well, we used one of the one-word channels on—

HEROLD:

What were we circulating it on?

MITCHELL:

--the drum, to assemble it—

HEROLD:

Ah, yeah!

MITCHELL:

And then that was put into a longer F track re-circulating line.

HEROLD:

Oh, how awful.

MITCHELL:

And then that was put onto a whole track.

HEROLD:

It was hard to do those things. It didn't have any core memory, nothing. No lines, too.

MITCHELL:

And to follow one of those words through to see what was happening-

HEROLD:

Oh, that would be . . . Yeah. If you dropped any, if you dropped it along the way, there'd be no knowing where it went.

MITCHELL:

And to look at it with an oscilloscope was almost impossible. It'd just drive you out of your skull.

HEROLD:

You could see building up these chains of information on these re-circulating lines on the drum, because you'd automatically get from one place to another.

MITCHELL:

I went through this consulting job, and it was really rather funny, because when we did the p.v. 250 and we had Stan Franklin as the consultant and we were talking about--I don't remember whether it was tapes or what--and he proposed the same system, I just screamed the top of my skull off, saying, "Never! Never, in no way." And I've already dealt with that. It was a great clever system, but boy! Nobody can fix it or find what's wrong with it. I used to have to construct special gates, you know, just glue diodes on the back of the machine, make gates just to [?] lines so they could look and see what was happening.

HEROLD:

One day the people from General Electric came down. I don't know who; if I remember who was there, Bob Johnson, Dave Zedd, and I don't know where you were that day, but anyway, four or five people came down from Palo Alto and they'd just got the other project for the big one back in New York vacuum computer, and they were desperate to know how they were going to do this. Why they came to J. B. Rea I don't know. But they came just for technical information as envoys or something. And they came in there and talked to J. B. Rea, and somehow I got involved in that meeting and met all those guys. And I liked them, and the company, J. B. Rea, was going nowhere at the moment, I thought.

MITCHELL:

Yes, it was going somewhere! Out!

HEROLD:

And I'd had enough of this Dayton crudding around and I didn't see the real future, and I also always like Palo Alto. And the guys seemed smart and the big General Electric Company which was going to be huge back in computers. So after they'd gone back, I contacted them and went up for an interview and got on.

[End of Tape 1, Side l]

[Start Tape 1, Side 2]

MAPSTONE:

Testing, testing, one, two. Okay. So that lured you off to General Electric, did it?

HEROLD:

Yes. Well, I think I was one of the first to leave the J. B. Rea Company. But I think it was going downhill and I remember I was kind of getting to feel something.

MITCHELL:

First rat!

HEROLD:

Before the other rats. Well, I could see the handwriting on the wall that J. B. Rea wasn't going to run pat. His money was eventually going to run out.

MITCHELL:

When the rest of us were bailing the water out, Henry left!

HEROLD:

[laughter] Right!

MAPSTONE:

Before we leave J. B. Rea, how did it all end? I mean, what was the specific finality of J. B. Rea?

MITCHELL:

Oh, it was a long drawn-out death actually.

HEROLD:

I left in August of '56.

MITCHELL:

'56?

HEROLD:

I came in '53, and we really got the machine designed in '54, and we did that delivery and all that Dayton mess was in the last half of '55. And then I came back out. I don't know what I did in early '66, but after that I..

MITCHELL:

Were you there when we installed the Dupont machine?

HEROLD:

No, maybe.

MITCHELL:

You'd already left. Because I know I didn't leave until about the following June then.

HEROLD:

Well, I left, I actually was interviewing with them in June and July, and I left, or started at least, to leave for G. E. at the first of August in '56.

MAPSTONE:

So there was the Dupont machine. Were there others after that?

MITCHELL:

There was one that was installed after I left somewhere for G. E. somewhere in the Southwest. I think what they really wanted there primarily was the drum memory.

HEROLD:

Yes. You know, as a matter of fact, I think I saw that machine. I was down in Phoenix one time with General Electric years later, and I saw J. B. Rea thing. I wondered and looked at it. I could hardly believe it, sitting on the floor of General Electric. I think they were using it just for the timing voltage or something.

MITCHELL:

I don't know. They wanted to drums, I remember, because I, at SDS, I ultimately hired one of the guys who had been doing maintenance on these things, or I didn't hire him, but I recommended him to the guy who was doing customer service, and he was hired. And he mentioned this machine and as far as I know, that was it, but ultimately what happened was the assets, I guess, were bought up by some place called Ferracast, where they made iron products. It was purchased as a tax loss. Someone had an excess of funds and decided he would buy this thing and make more money by a tax loss. I don't know if you understand how that works.

MAPSTONE:

Yes, I vaguely do.

MITCHELL:

But that's ultimately what happened to J. B. Rea. And a lot of the products were auctioned off.

HEROLD:

Did he go bankrupt, J. B. Rea? The company did.'

MITCHELL:

I don't know. Maybe.

MAPSTONE:

Where did that leave the responsibility for maintaining the computers?

MITCHELL:

Well, there were two of the guys who were maintenance men went to Ferracast and they worked for this guy whose name was George Morton, who ran Ferracast, among other companies. And they maintained these machines, and this guy used to call me periodically when I was at Packard Bell, and say, "Now we've got this problem, and we

can't really work it out. What shall I do?" And I'd say, "God, I don't remember how that works! I don't have any logic or anything. But why don't you try thus and so." Which frequently worked out. I tended to be very lucky about that sort of thing. As a matter of fact, I had just a great reputation for that at J. B. Rea, which was based on a huge lie. And that was: we had this in-house machine and we had programmers who would work on it in the evening. And during the daytime we would try to get the cards and the peripheral equipment checked out and working. Periodically I was doing something on the typewriter, as I recall, and I had, it was a one-shot circuit, which I replaced periodically with a different one which had different timing which would cause errors where . . .

HEROLD:

So much of the . . . I don't remember where.

MITCHELL:

And one night, this programmer who was working on it called at about, oh, it must have been three-thirty in the morning. Of course I was sound asleep and he woke me up and said, "I'm having this strange problem. Such and so is happening." I said, "Well, pull the module out of location so-and-so and replace it with a module that you'll find over on so and so." And I hung up. And the guy did it and of course everything worked because it was the proper module. But from that I get this reputation of being able just from a sound sleep of being able to diagnose this fantastically complicated problem! [laughter]

HEROLD:

Well, I did that a couple times, too, just because I knew the machine so much, we'd worked on it so much. Just change that flip-flop! [laughter]

MITCHELL:

Oh, we must add a lovely little story that reminds me of, when we'd find logic errors in the computer. Henry had the habit of taking little scraps of paper and writing down the problem and the logic change on this little scrap of paper, and just jamming it in his pocket.

HEROLD:

I'd walk out with it. [laughter]

MITCHELL:

He'd go home, and also at night he would clean all his pockets out and put this stuff on top of the dresser.

HEROLD:

MITCHELL:

And God forbid that his wife got up early!

HEROLD:

She pick the scraps up.

MITCHELL:

And clean up the scraps of paper and throw them out! That was like a week's work down the drain for everybody! [laughter]

HEROLD:

Yeah, I used to have my hands full when we were first checking out those machines. You know, rather than stop and write anything, I used to write it on a little piece of paper and have it in my pocket, knowing that I'd take care of it some way or another with more formal paperwork. They'd watch me pull all this stuff out and people would look with their eyes popping out! [laughter] "That your information?" "Yeah." [laughter]

MITCHELL:

He had another little habit which I loved dearly. When he and I would work together during the check-out, he'd say, "What's so and so?" Some signaling. "What's n-zero doing at this time?" And I _____ with the oscilloscope and I'd ay, "Well, it's true." And he would say to me, "You're lying!" [laughter] And I wouldn't believe myself and I'd look again and I would say, "No, it's true." And he'd say, "Insane. Wow, that's impossible!" And he'd start jumbling through these little scraps of paper, and, "Oh, yeah, there it is." But I like that little approach. I used it myself in later years working with people; I'd say, "What about so and so?" And they'd say, "It's true." And I'd say, "You're lying!" Really, you know, it sets people back. It shakes them up enormously.

MAPSTONE:

Oh, dear. So on to . . . How about on to Packard Bell, because that kind of is where you two again later pick up.

HEROLD:

Oh, I didn't go to Packard Bell.

MAPSTONE:

You worked with SDS. So that kinds of leads us into the SDS.

MITCHELL:

Well, first into Packard Bell.

MAPSTONE:

Yes.

MITCHELL:

Well, about June of '57, the company was really going glug glug down the drain.

HEROLD:

Russell was still there, wasn't he?

MITCHELL:

Dick Russell was still there, and he was working on some fantastic thing or other he was hoping to sell to somebody. I don't remember who. I think it might have been the G. E. thing, which he, I guess, he did sell ultimately. He

HEROLD:

He really . . . He was really heartbroken by that company's failure, wasn't he?

MITCHELL:

Oh, yeah. He really felt that it should have taken off.

HEROLD:

He really went right to the end on it.

MITCHELL:

But he suggested to me that I was going to be running out of work shortly and that if I was smart I would start looking around for some other job. And so I did. And I found, purely by accident, this little hole in the wall, Packard Bell Computer, which was just starting up as Max Palevsky and Bob Beck and George Gill and Vincent Van Prague, I guess, had broken away from Bendix. What had happened was, Max had come up with

the idea of a digital differential analyzer which, when he was working for Bendix, and had convinced someone that at the Redstone Arsenal that they needed it. Bendix didn't want to build it and so Max got Dick Ling, who was running the missile systems group at Packard Bell, to finance the thing.

HEROLD:

Well, it was a new idea. You could run all the integrators in parallel.

MITCHELL:

That's right. Nobody else was running it, doing it, had ever _____ the parallel DDA.

MAPSTONE:

Oh, that they were all serial.

MITCHELL:

All serial.

HEROLD:

One integrator to each one, separate and independent.

MITCHELL:

And they also--well, he got this contract to develop this thing, and also at the same time they were trying to develop the first high speed, solid state, analog to digital converter. They had divided their talents such that George Geel was going to do the a. to d. converter, and Bob Beck, who was really a logic designer, was going to do the DDA. They were having a few problems with the converter. I guess Max and Bob were ganging up on Geel, who they felt wasn't really progressing rapidly enough. And about that time I came in and interviewed and they offered me a job working on the DDA. I didn't know doing what exactly. I'd also gotten a job offer at Bendix. I was strongly tempted toward the Bendix job, but I talked to Max and said, "Well, if you offer me more money than they did, I'd work for him. And so he thought it over and agreed to do so. It was something like. . . I think I was making something, he'd offered me something like $900 a month or something like that at that time, which I thought was great. Anyway, I went to work for them; and as it turned out, they forced Geel out and Bob Beck took over the a. to d. converter and I took the DDA., of which Bob had designed the integrator, but had not done the circuits as yet, so I started at first working on flip-flop circuits. I'd never worked with transistors before.

I'd come from J. B. Rea, where we'd done nothing but vacuum tube circuits. Not too many people had done much with transistors at that time. As a matter of fact, there weren't very many switching transistors available at the frequencies that we wanted to operate, which was three megacycles. And we were using radio frequency transistors at that time. They were rather expensive, and I kept blowing them up. [laughter] And I felt guilty; I used to hide the burnt-up transistors somewhere. You know: "Where are they all disappearing?" But ultimately I came up with a workable circuit and we started building this really a prototype for DVA, which hence, I think, had one of each of the various units which were integrator, a multiplier, a constant multiplier, and what else? I think there was some other thing in there.

HEROLD:

You called this the Thrice, didn't you, or the Trice?

MITCHELL:

Trice.

MAPSTONE:

Trice. Can you explain, you know, how did Bob Beck go from the serial who into ?

HEROLD:

Well, that was the idea to start with, wasn't it?

MITCHELL:

Yes, that was the original idea. It was just that the speed of the . . . They wanted something which would be competitive with the analog machines.

HEROLD:

You used acoustic _____lines, didn't you?

MITCHELL:

Yes.

MITCHELL:

Yes.

MAPSTONE:

I really meant, how was it done? Not the idea, but how did--I mean, because up to now you've got it was all serial, because obviously it seemed to be state of the art to make it easier. Speed had some bearing on it.

MITCHELL:

They wanted to compete with the analog machines, and the thing would be that these, instead of having one integrator and a memory which would feed through these things serially through the one integrator serially, you would have separate integrators all operating in parallel in transferring in-formation through an analog patch board. So you would use this thing like an analog machine, except that the integrators would be digital rather than analog. And it would be very similar, in fact, to an analog computer, using digital elements rather then analog.

MAPSTONE:

And the memory was?

MITCHELL:

the memory was acoustic delay lines, which were . . .

HEROLD:

One line per integrator?

MITCHELL:

No, there were I think, two or three lines per integrator.

HEROLD:

Oh, that many. So what was the frequency of update?

MITCHELL:

Well, each of them operated serially inside the integrators.

HEROLD:

But how often did they get updated?

MITCHELL:

And it was a three megacycle machine. I think it was a ten microsecond update time.

HEROLD:

Update time. A hundred k.c. then you would have done. They would switch every hundred k.c. then to the alternate bit to free each other.

MITCHELL:

Thirty bits, right. Thirty bits, three megacycles. Does that work out right?

HEROLD:

Thirty bits and three megacycles? Yes. So. . .

MITCHELL:

So every ten microseconds you'd get a bit from one to the other.

HEROLD:

And they were all built in to each other.

MITCHELL:

Right. They would transfer information, and the analog frequency, which say, if one were generating sine-cosine or something, the analog frequency was comparable to that done by analog machines. There were several people, a lot of people that were interested in this machine. Some people even bought small machines and later larger machines, and we sold some rather large machines.

HEROLD:

Re-spendable, wasn't it?

MITCHELL:

Yes. You could just keep adding these things on.

MAPSTONE:

Oh, just add another integrator.

MITCHELL:

More and more integrators. And so we sold first machines that were not complete machine to people who would then buy more integrators and multipliers and what not. And it worked into a fairly good system, and people, I think . . . We sold one very large one to North American Aviation, who were simulating at that time both the X15 and the B1. I guess at the time it was the B70 or whatever. Later. . .

HEROLD:

When you cut it up, what did you have? Just plotters?

MITCHELL:

We had a. to d. conversters and d. to a. conversters going in and out. And they would, this thing then tied into a huge analog simulator. We'd tie it into the Electronic Associates' analog computers by means of digital to analog, analog to digital, conversion going in and out. We did a portion of the simulation digitally. I'm not sure if they really needed this, but I don't think so. I think it was again a matter of the funding techniques and financing this thing. But again, we sold another one. We sold, I think, a larger system to Redstone Arsenal after they saw the small one work.

HEROLD:

Oh, it was a great toy when it really did work. As far as running it, it ran.

MITCHELL:

Oh, yeah. It ran.

HEROLD:

It wasn't very fun if it was broken.

MITCHELL:

And finally it really ran quite well. And of course, as the digital machines got faster and faster, it obsoleted the need for this thing because they could simulate these things digitally. But at that time the digital computers were not very fast enough. But also under cover of the contract for the Trice, which was the transistorized, real-time, incremental, computer expendable—

HEROLD:

[laughter] Oh, God!

MAPSTONE:

Oh, I see! [laughter]

MITCHELL:

[laughter] It was a period during which people was struggling for great acronyms.

MAPSTONE:

Wow.

MITCHELL:

First you made up the name of your device, and you said, "Now what can T stand for? And how about the R? And the I?" But as a matter of fact, we got a patent on Trice that was . . . Schmiel Rumen and I ultimately were the patent-holders for this thing. Schmiel is now at the Whitesman Institute in Israel.

HEROLD:

I saw him there.

MAPSTONE:

How do you spell his name?

MITCHELL:

R-u-h-m-a-n. I think there's only one N. And the first name is S-m-i-l.

HEROLD:

A-i-l.

MITCHELL:

No, just S-m-i-l. Smil. Very funny guy. But then shortly after this--well, by that time the a. to d. converter, Bob Beck had started work on that and gotten it working and we were selling that thing and then we were selling Trice or whatever the plural of Trice is.

MAPSTONE:

Treece.

MITCHELL:

Treece. Or Truce? Truces? The company started making money and the company also started doing systems. We were also making digital modules, and we decided to build a small computer with would be useful in doing the systems work rather than designing a separate system for each of the jobs.

HEROLD:

First idea of the mini-computer really, wasn't it?

MITCHELL:

Yes. It eas really the first minicomputer that was built.

HEROLD:

Actually, you could put it into a relay rack. Could mount it inside a relay rack.

MITCHELL:

Oh, those first ones were not acoustic delay lines for Trice, as a matter of fact. We used distributed constant delay lines.

HEROLD:

Oh.

MITCHELL:

And that was a problem. Wow! The signals looked so incredibly gruesome by the time they'd gone through these delay lines that those were a little shaky. And then later, when the acoustic delay line really was. . .

HEROLD:

They were pretty shaky, too, weren't they, for the first few years?

MITCHELL:

Well, at that time they were non-existent. They were just coming out at the time we decided to build the PB250, which was our little computer, our general purpose computer.

MAPSTONE:

When did you start work on PB250? Date.

MITCHELL:

That was in . . . I don't remember exactly, but I think it must have been in late '58 or early '59. We started work on that, and Bob Beck did the logic for the machine. And it was really a simple machine where the whole computer was used for the input-output operations. If you wanted to. . . It used a flexer rider again for the basic input-output device, and if you just wanted to output a character on the flexer rider, which went at, I think, ten per second, then the whole computer would be tied up putting out those characters.

HEROLD:

Putting out those characters!

MITCHELL:

Then it would do a little computing and put up the next character. It held up for the whole time that that character was being put out.

HEROLD:

It used the whole thing to _____punch those holes!

MITCHELL:

And the holes, that's right, that's to read them. Or to read a character: the whole computer then would wait until the operator hit the key, so it'd just be sitting there, those whole computer. But anyway, the memory for this computer was. . . I don't know. Who convinced who, but somebody convinced somebody the memory was going to be acoustic delay lines, which were the latest thing for the state of the art. And it was only Ferrante who were building delay lines long enough and fast enough to use our needs.

HEROLD:

What was the clock rate on that?

MITCHELL:

The clock rate was two megacycles, and we had two millisecond delay lines.

MAPSTONE:

I haven't heard any. Do you want to talk about it, or is it off the records?

MITCHELL:

I don't think I want to talk about that because of legal bonds. [laughter]

MAPSTONE:

Okay. We don't want you sued.

MITCHELL:

But that--I'll tell you that off the record.

MAPSTONE:

Okay.

MITCHELL:

But, in any event, we built the PB250 and the circuits for the most part worked fairly well, but we had trouble with the acoustic delay lines, which were really were ahead of the state of the art, our requirements was, and we couldn't get them out at Ferrante. And we sent finally one of our men, Don Cooper, who was an Englishman, to, I guess it was somewhere in New York when Ferrante was building these things. And they would not let him into the area where they were building the things. They allowed him to test them, but not on their premises, and so Don stayed there so long that the company sent his wife and family--he had a young child, I think, at this time--out to live with him in a motel somewhere, He had, I think, two rooms in a motel, one of which was his laboratory where he tested these delay lines before they were sent, because what was happening was, they would send them to us in Los Angeles and we would test them, reject them, send them back, and there was so much time traveling back and forth, we were so desperate to get delay lines because the time was piling up on us, and people wanted--we sold these machines--and people wanted delivery and we couldn't deliver because we had no delay lines. Also our own programming staff and engineering staff were fighting over who would get the working delay lines long enough to check out peripheral equipment programs.

MAPSTONE:

Why did you guys delay lines? They really were not the best of the memories at the time, were they?

MITCHELL:

Oh, because core memories at that time were way too expensive.

HEROLD:

Did you have the same flip-flops and other circuitry that you had on the Trice?

MITCHELL:

No, these were different flip-flops. I don't remember. I think Ruhman was doing the circuits and I was doing the project engineer. I was head of computer engineering over there, and Ruhman was by that time the head of circuit development.

MAPSTONE:

And what was Franco's involvement?

MITCHELL:

Well, Franco used to come in as a consultant. He would come in when we, first of all, when we did the original design, he came in and looked at it and made suggestions on Beck's logic design for the thing. Just to get some new ideas which we hadn't thought of.

MAPSTONE:

Because he had already had done work on the IGP, which was under him.

MITCHELL:

Well, he had done--Right, right. By this time, he was starting to work on the first electronic desk calculator.

HEROLD:

He came up and was a consultant with us at G. E., too.

MAPSTONE:

That's right. He moved around, yes.

MITCHELL:

He was going around doing a lot of consulting at that time.

MAPSTONE:

Wow about Huskey's influence, because he had already designed the G15 at Bendix, but somehow there must have influenced Palevsky and Beck perhaps.

HEROLD:

He was up at Berkely at that point.

MITCHELL:

Well, they used to talk to him, but I don't think they used him really as a consultant. They knew, Max and Bob know, Huskey, and the way I got the story of Huskey's involvement in the G15, I don't think they really wanted him to be involved too much in the PB250. I don't know what stories you heard about the . . . fighting over who would get the working delay lines long enough to check out peripheral equipment or programs.

MAPSTONE:

Why did you guys get delay lines? They really were not the best of the memories at the time, were they?

MITCHELL:

Oh, because core memories at that time were way too expensive.

HEROLD:

Almost to the end of the—

MAPSTONE:

In 1958 they were still very expensive?

HEROLD:

Oh, yes. Almost to when we started SDS II. I remember the original idea was to put all the registers that were going to be delay lines in the original. . .

MITCHELL:

With the short registers, right.

HEROLD:

Yes. But finally at the last minute they just changed their minds on that and went to core.

MITCHELL:

That's right.

MAPSTONE:

But you did stay with the acoustic delay line for the 250?

MITCHELL:

For the 250, yes, but it was just a horrible struggle. Don used to tell a story of catching glimpses into the rooms where they were working in these rejects which we had sent back, and what they were doing really was heat--treating them in a way which really was a witch's art rather than a science.

HEROLD:

He got at back ways or something? [laughter]

MITCHELL:

Well, no--well, more or less. Because he peered in there, and here was a guy with one of these things open and a blowtorch in the other hand, and he was sort of heating this thing with the blowtorch very quickly, you know, and then withdrawing the flame and trying it, you know, and seeing the performance. And if it wasn't just right he would then give it a quick touch! with the blowtorch again, and really he just about, Don being a very straight-laced engineering type . . . (phone rings) You can leave that on. Don being a very straitlaced engineering type and really believing in-you remember him?

HEROLD:

Oh, I know Don very well.

MITCHELL:

He had rigid procedures on everything he did and wrote things up very carefully. He was really aghast at this.

HEROLD:

[laughter] I imagine he sent horrible reports back.

MITCHELL:

He telegrammed back to Max, you know, saying he really felt we should change the memory. But at this time we were really so. . .

HEROLD:

You were really locked in; you couldn't get any other memory.

MITCHELL:

We were just so committed to delay lines in the design of the computer. We would have had to a complete redesign. And also by this time Max felt that they really were not exerting every effort, and he went to see Baron D. Ferrante and complained violently to him, and they were threatening law suits of various sorts, and _____ felt we were going to damaged.

HEROLD:

I imagine.

MITCHELL:

In any event, they really started working like mad on the delay lines and started--the state of their art started progressing to the point where they were able to deliver some working delay lines. Not too many, but at least our inventory started building up to the point where we were able to stop fighting over who could use these things. And as a matter of fact, we also had problems in the programming, in that whoever had hired the programming staff at Packard Bell for the g.p. had erred in hiring big-machine programmers. They hired this group of programmers for the PB250, who had worked on nothing but 70-90's, and their whole outlook was an 70-90 programming, you know, with all this great input/output facility. And here we had this little nothing computer which was completely tied up on a flex rider.

HEROLD:

On putting the cards out.

MITCHELL:

Yes. And they started off writing--of course, you had to write a bootstrap.

HEROLD:

Oh, I remember. He showed me all that.

MITCHELL:

The way the bootstrap worked was that you had . . .

HEROLD:

You had one bit going for awhile.

MITCHELL:

. . . one bit at a time off the flex rider. Well, they had to work it that way. That was the design. And first of all you had this binary paper tape which was read into the flex rider making a bootstrap loader which would then load at least a character parallel loader on top of itself. Well, these guys knew nothing about the timing involved in the flex rider, and they had this thing which would miss cycles--here's the whole computer tied up on every cycle, and this thing would miss cycles on the flex rider. Well, by this time the computer was running, and I was working on making a photo reader work so that we could get some decent timing of input to the computer. And I was having all kinds of problems from both programming and hardware problems in making the photo reader work into the 250, because, of course, I was much faster than the flex rider. And what would happen is--I didn't know what was happening at first because what would happen is, I'd run this program for the photo reader and it would wipe out every program that was in the computer. And there I'd have to lead this bootstrap in. Well, it took something like . . .

HEROLD:

A half hour or something.

MITCHELL:

It took roughly half an hour to get the program. And here I'd get about maybe a minute of check-out time on the photo reader, wiping out this program. And then there was another half hour of waiting around for the damn program to read in again.

HEROLD:

Why didn't you put it on under the line?

MITCHELL:

And it was unbearable!

HEROLD:

Why didn't you put it on under the line? You could copy from it.

MITCHELL:

I did!

HEROLD:

I mean, keep a copy of it in there somewhere that it couldn't mess up.

MITCHELL:

But that's not what happened. It was an error in the photo reader program, which I couldn't find, you know. That programming error would wipe out the other ones. And, you know, it apparently would run through every memory delay line that was in the computer. So there was nothing left. The machine was a total blank by the time was thing got through. There was no way out of it. So finally I sat down, I just dropped what I was doing, and I sat down and I started to write a loader myself. I at first had to invent the programming sheet, which was of this delay line.

HEROLD:

They hadn't done that?

MITCHELL:

They hadn't done that, no. Uh-uh. And yet all this time they're writing programs like Nim and, you know, keen programs for displaying this thing. They couldn't even get the damn programs in and out! So I wrote this program which would load in, you know, and not miss any cycles on the flex rider and also such that you could type in by the flex rider and change things in another program. You could type out. You know, it was a real utility program. It also did a check. Did it? I don't remember if mine did a check sign. Any-way, I had one tape of this thing when on which I had JM Loader-the Jack Mitchell Loader, you know. Of course, I had complained _____ to both Max and Bob Beck that this time I started again getting the photo-reader going. Of course, I didn't have to wait so long now, and finally got the damn thing working. But also at this time they started hiring small-machine programmers, and I think Evel Borgers was there at that time.

HEROLD:

Was he there?

MITCHELL:

And Pete England came to work. And it was Pete who took this JM Loader and--I'm not a programmer.

HEROLD:

He really polished it up.

MITCHELL:

He polished it up, and he added, I don't remember, he added he check sign, but he added a lot of features that where you could also punch out a program that you had with a check sum, and then when it was written, that would be tested to see whether it was proper and so on. He changed the name of JM Loader to _____ Utility Package. And, of course, that was later updated. Someone else threw in a lot of more features. Another young programmer they had in redid it again. And finally it was really a useful little program. But that was a wild situation. (doorbell)

HEROLD:

I remember it coming

MITCHELL:

There's the couch. (interruption in interview)

MAPSTONE:

You were talking about programming actually, the JM Loader.

MITCHELL:

Oh, yes! My claim to fame. Well, ultimately, they were a good group of programmers in there. Evel Borges was in charge of that group, I believe. The computer was rather successful and the company started doing very well. The way the company had been formed initially was that there was Packard Bell Electronics, the Parent corporation, owned 70% of the stock in Packard Bell Computer Corporation. There was an arrangement whereby--am I referring _____?--there was an arrangement whereby at the point, I believe, where the Packard Bell Computer Corporation grossed five million dollars in a year or more, Packard Bell Electronics would have right to exchange all the stock for Packard Bell Electronic stock, the other 30%, at whatever the current market was. And I think Packard Bell Computer stock would be worth so many dollars in whatever the current public value of Packard Bell Electronics stock was. Well, in any event, at the point where we did five million dollars in business, they elected to take that option. They said, okay, they're going to make the trade. Well, by the time--I think Packard Bell Electronics was something like twenty-one dollars a share at that

point--by the time the actual transaction had taken place, I believe it was something like ten dollars a share. Max was livid with rage, and went to Bob Bell, who was running Packard Bell, and said that he made to re-transact this thing because "we've been gypped!" And if they didn't he was going to quit, Max was going to quit. Max had made this threat before this on occasion, and this time they told him, "Okay, quit." And so he did. Of course, there were these tearful farewells where Max. . . Everyone knew he was going to form another company, and he said he thought it for sure he would see most of us again very soon. And sure enough, he began to form a new company, which shall remain nameless until we get to it.

MAPSTONE:

Right. I take it that at Packard Bell already Max was no longer technically involved in its management.

MITCHELL:

No, he was . . . Right. He was really . . . Well, he was always involved in the technical decisions. For example, it was Max who decided what size computer we would have, and even in later years, at SDS, he made those decisions in terms of product planning decisions. And he kept himself fairly abreast of what was happening technically throughout the industry.

MAPSTONE:

But he wasn't in there designing circuits or that design.

MITCHELL:

He didn't design, no. He stopped doing that right around at the beginning of Packard Bell Computer. When he left Bendix, he stopped all design work.

MAPSTONE:

What happened to the Packard Bell run computers, just to play it through? Did they go on?

MITCHELL:

No, they were bought out. Packard Bell finally sold the computer group to Raytheon, which became Raytheon Computers.

HEROLD:

It moved to Orange County.

MAPSTONE:

Oh. But Raytheon was bought by Honeywell.

MITCHELL:

Was it?

MAPSTONE:

Isn't it?

MITCHELL:

I don't know. That was a big mistake. I don't see what they bought if for.

HEROLD:

Raytheon had already had something going in Orange County, and then they added this to it and brought most of these people down to Orange County.

MAPSTONE:

Raytheon . . . The radar was probably really an early part, really early pioneer computer.

HEROLD:

Yes, they had been in the computer, though they had something wrong with it, too.

MITCHELL:

Yes, that's, as a matter of fact, where the _____ came from, was Raytheon. He had worked with a guy in magnetics whose name escapes me at the moment, but the guy who has most of the patents and had written most of the articles on magnetic switching those things, which was really Ruhman's forte. Now what was his name? I can't think of his name.

MAPSTONE:

Okay. So Packard Bell was bought by Raytheon. That's another link. You see, this is a whole, it's an incredible, link! Everything links up.

HEROLD:

That was quite a bit later, though, that that was set up. 1963 or '4 or something like that.

MITCHELL:

That was when--yeah. See, Packard Bell financed Packard Bell Computer when they had lots of money rolling in. They were doing the support for the Thor missile system, ground support equipment. Of course, the country switched from Thor to other more advanced missile systems, and Packard Bell was out. They had this group and at that point, they management wanted to keep that group together, and they underbid Collins on a redo of a Collins project, which was just a horrible error in that there were also penalty clauses and so on in this thing. Collins, of course, was in no hurry to give Packard Bell the drawings, and they'd search around here and there, never did know whatever happened to that drawing or this drawing. So Packard Bell Electronics lost, I think, something like twelve million dollars on that deal, which really sent them down the drain.

MAPSTONE:

Yeah.

MITCHELL:

And in order to get some money, they sold off what was left of the computer group to Raytheon. And they realized some gain from that. I don't know how much. But at the time we left, it was the only profitable portion of Packard Bell, was the computer corporation.

MAPSTONE:

So they did go on and they built after the 250 _____?

MITCHELL:

Well, we were thinking of building a new computer when we were there, still there. We were just starting—

HEROLD:

Bob Beck had done some of the drawings. He had started the design of a machine called the PB350, which was going to be . . .

HEROLD:

The 9-10, practically.

MITCHELL:

No, not really. As a matter of fact, they wanted to avoid them. When we got into SDS, that was one of the reasons they were looking for good logic designers. They were afraid Packard Bell would sue SDS on the basis that Beck had done this design at Packard Bell.

MAPSTONE:

Yeah.

MITCHELL:

And then started at SDS and used the design he'd done there. And in order to make it apparent that we hadn't done that, they were looking for very good logic designer. And I said, well, you know, I had already recommend Henry at Packard Bell when they were looking for people, and he'd turned down a job offer there. So I said, "You know, what about Henry Herold?" Then Max called him again and offered him a deal with SDS.

MAPSTONE:

Okay. Oh, that's neat. There's sort of a connection. Yes, this is something I've often wondered and talked about is, you know, as you people were moving around, didn't you face this kind of problem, legal problems, patented problems?

MITCHELL:

Oh, sure.

MAPSTONE:

Where one company could have sued you for because you did some work here and then moved there and did the same thing.

MITCHELL:

Of course, that's been done, throughout in the East, mostly. There's the--who is it? The CDC Univac thing, and there have been others. There was one recently which I don't recall.

MAPSTONE:

Oh, Control Data Warrants. That's probably it. But back to that.

MITCHELL:

Right, but there have been other things in terms of the patents. You know, when we started at SDS, as a matter of fact, we had a patent attorney coming around looking for anything to patent just so he'd have some bargaining position. And he was talking about patents. We didn't feel that anything was patent able. But at that time he was interested in the interim system, I remember. But at that time he was interested in the interim system, I remember. He thought that might have some aspects that would be patent able.

HEROLD:

There were finally some patents made. And I might have got a couple few patents from up there.

MAPSTONE:

Would you let me see these?

MITCHELL:

Did you?

HEROLD:

Yes. And a lot of them at GE. Gee, a lot of them. Ridiculous amount.

MITCHELL:

Well, people used to try to patent all this stuff and get the patents out. How really valuable those patents were . . .

HEROLD:

Sell them by the pounds. They'd just sit there and trade them by the poundage, you know.

MAPSTONE:

Keep Delores working. Was the PB250 patented at all, and if so, under whose names? Do you know?

MITCHELL:

I don't think it was patented, but one interesting facet of the PB250 was that in the advertisements for the PB250 was credit was given to Bob Beck for the logic design.

HEROLD:

First time I'd ever known that.

MITCHELL:

The ads said, "Design by Bob Beck." I'd never heard that before. Never.

HEROLD:

The first time I've ever seen that before or since, I don't think.

MITCHELL:

Or since, right.

HEROLD:

It just didn't happen.

MAPSTONE:

That's intriguing. Okay. Let's switch over and about now to GE. And do you know what, for instance, what made GE even bid on Armac, because.

HEROLD:

General Electric had a guy named Barney Oldfield, I think, that was very high up in General Electric. They'd bid against several other competitors for this Bank of America job, and I think in a very little bit, because they felt the really should get into the computer industry. They saw the hand-writing on the wall than in the future computers were going to be big and so General Electric felt that they should get it on it. This was all before I was there. They'd made this very good bid. The Bank of America was going to . . . had been working with SRI, and SRI had built this great monster of a special purpose thing. Unbelievable. But now the idea was to make this thing more commercial, and actually usable. They were asking for bids, and I don't want to just go into politics, but this guy Oldfield and ____ _____ could somehow take into Bank of America and got the thing. I think they actually made money, as a matter of fact, on the contract as well. But they bid very low. So they has the contract. By the time I saw them, they'd gotten the contract, and they took a few people from the East--I think mostly Schenectady and a few from Syracuse-that were in an electronics lab back there. And they brought them out to Palo Alto--Menlo Park, as it was then--to work alongside the SRI people and start up their own. They really, I think, eventually . . . They had originally thought they were just going to make a copy of the SRI machine, but it turned

out to be _____.

MAPSTONE:

Was any of the work that SRI did unable?

HEROLD:

I'd say almost none, except for the probably the flow of information that they'd got. They had gone to the bank and found out just what kind of in-formation had to be processed so that the actually processing would have been the more because there was none carried over. When I first got there in August of 1956, people in the-- there was very much confusion, and there was no definite plan. We were talking about all kinds of systems and approaches. It was a big, frightening thing to approach, and we knew how to make system. And I think then they still hoped that they could use a big chunk of the SRI machine. We'd approached them, had the SRI people talk with us a great deal. And they had been working on it for years. But their system was completely wired for special purposes, and not the way, I think, you'd need for _____ I think we brought a couple of points were passed into this; we had some sort of an internally _____ machine around a specialty line thing like that. And it was so mighty, it'd fill up room and rooms. You couldn't believe such a thing could . . . Huge, big vacuum tubes and it was just, wow, big. I mean, like four rooms of it.

MAPSTONE:

Was it like a Whirlwind size?

HEROLD:

Yes. It was the biggest thing, I think, I'd ever seen. I don't think any of the whole thing ever ran at all. It would be hopeless to try to get any of that. It was all, as I say, special purpose. I don't think there were any instructions that came from the memory at all.

MAPSTONE:

What about the work that SRI--I guess it was SRI--did on the-- was it? MICR, Magnetic Ink. . .

HEROLD:

Magnetic Ink, yes. Yes, they had a bar code scheme. But I could check if they were putting bar codes back then. But I guess it was SRI, but they wanted to go, they wanted to go to the _____ coding. So it was at that time, I think, that SRI people were probably leaders at the time, and the GE people knew it too. That was sort of aside project alongside of the computer development, was, how are we going to read the

check? That was a big problem but I don't think it involved them quite so much.

MAPSTONE:

Okay. What was your area of involvement?

HEROLD:

Well, I was hired to come in and be a logic designer, so virtually just did systems. And how were we going to handle all this information, and should the short checks be by account numbers before you start processing them, or should you . . . So, all right, I had a big check system that fed them mechanically to read checks and then sort them. Other questions: did you do a partial sort of take checks at random and then let the computer do all the sorting before we started processing them? It was around. A lot of systems work. Finally they got the idea to read the checks magnetically and let the computer do all the sorting on tape. And they decided that they'd build a machine. Well, we decided we'd make a solid state. Transistors were the thing all of a sudden. They were coming in. And so me and Dave Masters and I and Dave Masters. . .

MITCHELL:

I guess it was Masters and I.

MAPSTONE:

They must be--and me.

HEROLD:

Masters and I went and retired for about a month in somebody's garage that had a nice garage where we could work. The two of us designed _____ _____the early computer. We finally got it going. Boy, we really went. They also had a thing called a paper processor, a back-up computer that was made to do the preliminary accounting and reading the checks and storing the information on the tape, sort of picking up the data and deputizing it. And then those tapes would have been sent over to a big computer, the one I worked on. But the smaller machine never got off the ground, so they . . . The big computer did the whole thing. And we got up to a hundred thousand accounts and I think we went higher up on that big machine. And the checks would just go and go in the machine. It would take about four years before we did something faster.

MITCHELL:

I remember the stories about how the checks would pile up . . .

[End of Tape 1, Side 2]

[Start Tape 2, Side l]

MAPSTONE:

Testing, testing. (pause) Jack, you were going to tell us how you heard the story!

MITCHELL:

Well, the way I heard the story on the check sorter was that there would be piles of crumpled checks all being flung out on the floor.

HEROLD:

Oh, they did! They did. Let me tell you, we had plenty of problems.

MAPSTONE:

That must have been a real problem, because checks don't come all nice and smooth and well-handled.

HEROLD:

Oh, it's a very, very big problem. They worked and worked and worked on those check sorters. It was really a big problem. Naturally the biggest part of the system, because they both have magnetic ink and coating, reading it properly and handling all those different sized documents, dirty, crumpled, all kinds! Of course, you don't have to have a hundred per cent, but there had to be an operator there to pull out a small percentage of the really wrecked ones.

MAPSTONE:

Can you refer me to some names of maybe people who were key in that area?

HEROLD:

In the actual check sorter area?

MAPSTONE:

Yes.

HEROLD:

I really didn't know those guys very well. I can find. . .

MAPSTONE:

Was the SIR?

HEROLD:

No, they were probably originally. I'm sure originally they were involved. Sidney Bowes did part of it; I know that Sidney Bowes were' subcontracted out at General Electric, because they wanted to develop a machine. But GE finally committed its own check sorter. Actually manufactured them and everything during the time the project was going. The first we brought was the 51 check sorter. I don't know the names of any of the men working on it. I knew there was . . . I can remember the people, but I've forgotten the names. I know some people who would remember, probably.

MAPSTONE:

All right. I'll get back to you and maybe you can pursue it some more.

HEROLD:

Anyway, at that time Bob Johnson was . . . When they first came there was another guy, but Bob Johnson soon was running that outfit. He was now the vice president of Burroughs Corporation, and lives in Detroit. The people I worked with were Bob Tucker and Dave Masters, who I still go see a lot, and who lives in Palo Alto still, and Lauren Writght, who did the magnetic tape tie in with us, and who else did we work with? Well, there was Dave Zaea, who worked on the paper processor, and J. Leventhal, who's still working for Raytheon somewhere. All very intelligent guys, and a few of them, I think, Bob Johnson and Dave Masters, came from General Electric. And of course Gerry Allard showed up, too. He too came from General Electric. He was a circuit designer, a circuit designer on the . . . And we had a lot of fun. It was a marvelous project to work on because it was a real challenge. We had a definite goal in mind that is, making those checks go through that thing and keeping track of all those accounts. It's real responsibility. And it was fun. We had a good team of people, and it was just starting up a whole, whole outfit that was brand new.

MAPSTONE:

There was really, I assume, an unusual way of approaching things where a customer--in this case, a commercial--actually came to a company and said, "Build us a machine."

HEROLD:

Right.

MAPSTONE:

Rather than your company building a machine and then searching for users.

HEROLD:

Yes. We had. . . It was quite different, I think. They realized the Bank of America--I think they were rather forward in this respect--they realized that they couldn't hire girls to do this accounting work for they'd get swamped by the amount, the sea, of paper. It was horrible. They had to do something. So they were willing to so they took this one. They'd already financed this, all right. I think they thought, believe me that we would just simply commercialize that SRI product, just simply copy the SRI machine and put it in a smaller package. It turned out we just redesigned the entire thing, such as a . . . Then went to a storage program machine.

MAPSTONE:

Were you, again, were you, apart from the magnet check reading, were you advanced in the art at all, unlike the others?

HEROLD:

I don't think so. We had a good team of programmers, a big team of programmers. We felt that it was a good program, too.

MAPSTONE:

Were you working closely with the programmers?

HEROLD:

Oh, yes! They were helping us originally, particularly they were . . . They wanted certain features in the machine, certain sorting constructions and comparison instructions and that sort of thing. It was a decimal machine.

MAPSTONE:

So again this was way in advance of in the sense that most machines, up to now, had really designed by the hardware designer.

HEROLD:

Well, this was still somewhat that way, although they did have more of an input here. As I say, there was a big preliminary period before when we weren't sure what we were

going to do before the design was to--before the architecture; that word wasn't used then--before the architecture was really finalized. There was a lot of people of different types, programmers and assistance people and so forth, all had inputs as to what kind of machine should be built for this. Because we didn't really. Because we really knew how to . . . It wasn't just putting out a product that was going to sell to the customer. No, we had so many checking accounts that we had to satisfy all of the Bank of America. There was thirty-six machines. Each one had to be able in capacitate-what was it?--over a hundred thousand accounts, which had an embodiment of about one check per day per account. There are an awful lot of checks every day you've got to handle and you've got to have back-ups because you can't allow these checks to stack up. You've got to be sure that the accounting procedures are right. You know, it's really chaos if you lose accounting on it. It's just imperative that you maintain all kinds of check . What do you do if a computer goes out? What you do is you fly checks to other places so you really have to have more capacity. Oh, it was a tremendous system problem.

MAPSTONE:

So this was thirty-six—

HEROLD:

We had eventually thirty-six systems or something like that, built for the Bank of America, all in California.

MAPSTONE:

Each one was autonomous, working on its own? Or was it linked into a central lead?

HEROLD:

Some of the installations had two or three computers on the same location. Like the one in Los Angeles, I think, had three, and the one in San Francisco had two. the first one we installed was in San Jose and there were a couple of them in Sacramento. I don't know where the hell they all were made. Then to that one branch they'd send checks, too, and picked up a _____ and there was no other process. They'd work the computer all night long, and they'd stagger the statements so every day they had one third, a third or one twentieth or whatever it is, and these statements would be automatically turned out and send out. The thing really worked. By the time we had it done, it was really going. It was quite--it was very--self-gratifying to see that: "Gosh, the thought of it, you could stand there and watch this great big monster sending the checks, just going through like you wouldn't believe. Well it worked, it was really going fine.

MAPSTONE:

All right, Jerry mentioned something about you had designed an error checking feature.

HEROLD:

Yes, we had error checking.

MAPSTONE:

Which was a pretty nice--he said it was--a pretty nice piece of design.

HEROLD:

It was non three; we had non three checking on this, and _____ as I said, so it would just cast out three on all the other processes and just do them to check them on all the arithmetic and also check the memory. You'd use the same, same feature. I don't think it was anything really unique. It was two bits for every instruction. Every word had a two bit character that indicated that you had the module through there. Mainly went through from the back_____ there'd be so you could cast things out of it if you had three. As you come down in the regular . . . So we had that. We had an old , but I don't think those instructions were used a great deal, but they were used in the small one to calculate the service charges and things. The machine was not fast. It was decimal, I think it was. Anyway, it was a sort word length. I thin it was eight or ten decimal digits per word, which it had no word for a longer number. We had, oh, I think a frequency of about two hundred k.c. It was a big machine. And for those days it had the capacity, and of course we had a core memory. It was the first machine that I have ever, you know, that I've worked on that had one like this, but it was slow. I think it was thirty-two microseconds or something like that per cycle time. I could hardly believe it. [laughter] But it worked. You know, it was a lulu.

MAPSTONE:

Where did you get the core from?

HEROLD:

We bought them originally from--I can't remember. Maybe it was Ampex. And from there and I think several sources.

MAPSTONE:

Telemeter Magnetics, maybe?

HEROLD:

Yes. That sounds right. That sounds right. A big rack of equipment or two or three racks for just a few hundred--I think we had a four hundred, four… memory, you know,

with thirty-two microsecond cycles on it. It filled up the whole rack of equipment and all the power supplies and everything. I couldn't believe this. But, man, for an access memory that was pretty big back them.

MAPSTONE:

What was Franco involved with? You mentioned his earlier.

HEROLD:

Well, he came up several times to make suggestions on the computer design and look at the motor and check it and see if it was an efficient design. Any comment that he wanted to make. And he got to know the machine fairly well. Of course, he knew Bob Johnson! Bob Johnson and he had worked before together, I think, somewhere. So they were good friends. Bob Johnson had come from Cal Tech and I think that at Cal Tech he had known Franco. So he came up and I got to be fairly friendly with him. I haven't seen him for a long time, but we were good friends, too. It was, after there, we had a lot of fun. It was really one of the most exciting jobs I've ever had, after SDS. It was such a big, brand-new. . . Everyone was working together on a real project that was of consequence. And it was fun and finally it was successful.

MAPSTONE:

I think you've finally just hit the key, that it was a real project of consequence, where maybe some of these area machines had been sort of seat of the pants type things and perhaps didn't have the real sort of impact on you the designers and builders.

HEROLD:

Right. That was a big part of it, but also--well, I guess all the companies I'd been at before, come to think of it, were just starting out too. What happened was that they, General Electric, decided that they--they got, incidentally, they got another huge project with the National Cash Register; they were going to build, just manufacture, these 3 to 4 computers for National Cash.

MAPSTONE:

Right.

HEROLD:

And they were going to do that and they decided they would set up headquarters and the whole thing, General Electric Computer department, would be in Phoenix, Arizona. So they set up this enormous building out on the outskirts of Phoenix. And our computers, actually, the _____ computer, was also manufactured down there, too. So I

was very frequently down on business trips to work with manufacturing or test the running when the machine is going or _____ of some sort. Going to Phoenix a lot. Well, I didn't like it. I'd have had night-mares if I'd gone to Phoenix. After all, we loved the San Francisco area, and we liked to go to Phoenix on trips, but to move there was horrible! They went there for the right to work laws, I think that Arizona had. And the desert just didn't appeal to me that much, so I just couldn't force myself to move there. And that's how I eventually left. I just couldn't . . . And also the management that were in GE, the higher management, which I was not directly concerned with but I could see, first of all, it was full of politics. Terribly full of them, because they thought, "Here's General Electric with all the light bulbs behind it and so there; so chance of losing money and they can move the computers." And so they were just playing politics like you wouldn't believe. And then most of them know nothing about computers. General Electric had the idea that if you were good at motors or turbines, if you were a good manager there, you'd be a good manager anywhere. Well, I don't think that's true, and I can do without the . . . And so they just made a lot of decisions that were really loaded with politics and completely sat on top of it for me. That prejudice and this prejudice, _____ understand.

MAPSTONE:

They didn't follow through with it, though, did they? I mean, after Amac there was no continuing it.

HEROLD:

There was no other, no, they just started losing business by the end and I think they got to the point. . .

MITCHELL:

Well, they built other machines.

HEROLD:

Oh, yes. They had a whole line of machines.

MITCHELL:

A whole line of big machines that they were building.

HEROLD:

Sure. The 650, 25.

MITCHELL:

They sold quite a few of them.

HEROLD:

Yes, they sold a lot of them. They had the . . .

MITCHELL:

4-something?

HEROLD:

Oh, they had a twenty-four bit machine--a twenty bit machine, and a twenty-four bit

MITCHELL:

The also had . . . What was that series of machines they had where you'd just change one module and the frequency of the computer was changed?

HEROLD:

Oh, that was a game they were playing in. For a lower price they put in a slower clock, and sell it for half the price. [laughter] Was that the 625 or the . . .

MITCHELL:

Something like that.

HEROLD:

They still sell some of those.

MITCHELL:

They still sell those machines under the whole series, a whole string of

HEROLD:

machines.

HEROLD:

They're still running those machines. They're still going, I mean a lot of them.

MITCHELL:

They finally sold out to . . . Who was it?

HEROLD:

_____, again. That's right. Okay, but I guess what I meant was they didn't, after they'd built Ermac, they really had an edge on the banking business.

HEROLD:

Oh, they had, really. We were the first ones in there but then they dropped it.

MAPSTONE:

And then they dropped it.

HEROLD:

IRM came in and just took it away like candy from a baby. It was ridiculous. They did not follow up and they should have redone the machine, come out with a new line of backing machines, and followed it up. Somehow General Electric didn't feel that banking was their thing, because they'd never been in the business of the fact of industry before, and they got interested in computers that would monitor electric companies and that sort of thing, and process control.

MAPSTONE:

Process control.

HEROLD:

They were more interested in that, and they just left the banking business sort of falter on. I think we used to scream, but again the people that were really interested in banking were all up in Palo Alto, or most of them were, and we weren't loved so much in Phoenix. Most of those guys did not want to go to Phoenix, including me. They did not want to go to Phoenix. It was unfortunate that they decided to do that, from our point of view. So…

MAPSTONE:

What were you doing for time?

HEROLD:

So not many of them went down to Phoenix, that's all.

MAPSTONE:

Do you want to cut it? (RECORDER OFF)

Okay, just, without going into great details of the machines, let's just sort of talk about this getting SDS going.

HEROLD:

How we got it going?

MAPSTONE:

Because, after all, that really is the American Dream of the computer business.

HEROLD:

Well, I know Max for a long time. I'd always known him slightly and I think I'd interviewed once for a job at Packard Bell and I had always seen him at the computer conferences. Max knows everybody in the computer industries, so he knew me. I had left GE and went to Hughes Aircraft, working on a great big radar control computer. Somehow--I guess Jack had prompted him-- but at any rate, I knew he had quit Packard Bell. I was not that much in contact, but he phoned me across town--I was located in the phone book--he called me across town and he said he was starting a new company and would I be interested and come on over and meet him. So I come over to his house one night, and he indicated preliminary plans all laid out there, and he was talking to me. We went through a big bit of what he liked and what I didn't, and I went and what the profit would be. So I thought about it and wasn't sure. When I drove over to his house, I was thinking, "Well, this is a strange idea. I've got a big job at Hughes and I have some thirty-five or forty engineers working for me." I thought, "Gosh, you know, I can't escape _____forever." But as I left his house, I thought, "Well, it's not too bad. Maybe I should take a chance." Also I'd just recently heard a speech by some guy who said that the American male was losing his _____and we've got to make decisions and if you're not fighting with your boss a lot, they you're not doing your job, and you should be getting out on your own and . . .

MITCHELL:

You mean, there is someone who listens to those things? [laughter]

HEROLD:

But I was sort of really, you know, rather than committing decisions, people should be making their own decisions, and there's nothing wrong with being rich or at least trying

to be and so forth. And I was sort of, that one bugged me when I had to . . . They made it, and I was not very happy working in military environment. So then he bothered me, I guess, a week later, and so I said, "Okay, I'll do it." I talked to Jack. I had to talk to him because we had worked together at J. B. Rea and I said, "Well . . ."

MITCHELL:

Who else had kept in touch in between?

HEROLD:

Yeah. And I remember I came over and we had lunch at the Pancake House or something. Anyway, we talked and talked and talked about this guy and how it is working for Max, because I'd never worked for him. I knew he was a dynamo and I was a little bit worked about that, because it is hard working for Max. I think everybody's who's worked directly for him has had trouble. He's really a hard guy. So I was worried about that. And then the thing with changing my job, giving it up and so forth. Finally I decided I'd do it.

MAPSTONE:

What was Max's . . . How did he get financing?

MITCHELL:

Well, first of all, you know, he started. . . When he left Packard Bell, he first started thinking about what he wanted to do. And it was obvious he does have to start a computer company. He just started talking to people and finally he talked to someone at Hayden Stone, who was an officer at Hayden Stone, a guy name Sperry, who had a--I can never remember which was which. There were two Sperry brothers.

HEROLD:

Ron Sperry.

MITCHELL:

And one of them was an officer at Hayden Stone. He was executive vice president or something. And the other one was running this small company--that the heck is the name of that? I don't know. It was some company which imported one of the British machines and tried to sell it here in this country. And they weren't really doing very well. These people were rather rich. The had. . . I think they were married to Sears money, the original Sears people_____, and they also had done fairly well on their own. And they had lots of money. They set up the financing, primarily the one who worked for Hayden Stone, arranged all the financing and the Sperry brothers, I think, put up a lot

of the money themselves. Some of the money was put up by an investment firm run by Marve Browday, who was personally a Los Angeles city councilman whose wife is related to the Sperry boys. She's, by the way, a psychiatrist, lovely . . . And they just got this thing together where they arranged the financing of it. And it was primarily the elder Sperry--or the younger Sperry brother--who arranged the financing. And then the next step was for Max to get the people together, and also to formulate a plan of what we would build and a schedule of how long we were going to take to build it, both being impossible.

MAPSTONE:

[laughter]

HEROLD:

He only had half a million to start with. That isn't very much.

MITCHELL:

Well, it was a million committed. There was a million dollars committed and I think something like, used of that committed million dollars, something on the order of $650,000 before we turned the company around and the money started coming in. We were supposed to build three computers, which were going to be the 9l0, the 920, and the 930. And as we got these people together-there was myself, and Henry Herold, and . . .

HEROLD:

Emil Borgers.

MITCHELL:

. . . Emil Borges, and Harald Largent, who came a little later.

HEROLD:

Bob Beck.

MITCHELL:

Bob Beck. And in order to avoid the legal complications from Packard Bell, we decided it was Bob Beck's . . . Bob Beck would do the circuit design, and Henry, Emile, and I would do the computer. That's the way it worked out. We got another guy in who was to do the memory, a guy that we stole from Ampex, which was a mistake.

MAPSTONE:

I assume by now you were software-oriented to some degree.

MITCHELL:

Well, Emile was.

HEROLD:

He was a top man.

MITCHELL:

Emile Borges had been in charge of the programming group at Packard Bell Computer.

MAPSTONE:

Yeah, right.

MITCHELL:

I was in charge of the computer engineering group. I was strongly hardware-oriented, and Emile was software-oriented, and Henry was hardware-oriented. So it worked out, I think, just extraordinarily well for the three of us, and we just had an absolute load of fun designing these computers.

HEROLD:

Max was smart. He got guys that had been around for a long time and had made their mistakes before and were experienced.

MITCHELL:

This was one of his statements at the time, that he only wanted people who had made all the mistakes, at least three times before. [laughter] And we all had. And different mistakes, too. [laughter] And so we took out the pitfalls as we went along.

HEROLD:

We had some really good ideas, though. We did have a lot of fun on it.

MITCHELL:

And we had an impossible schedule. We were supposed to get designed three machines and get them out within a year. And as we started designing the machines, it turned out

that the 920 and the 930 became one machine, which we choose to call the 920. And so we designed. . . Also it was impossible to do three machines in a year. It's really impossible to do two machines in a year, but we did it. And we actually delivered the first 920 within eight months, I think, of the inception of the company.

MAPSTONE:

Did you really?

HEROLD:

Right. 910, wasn't it?

MITCHELL:

910 I'm sorry.

HEROLD:

Yes, we had it out in about that.

MITCHELL:

Yes, we delivered one to a customer within eight months of the inception of the company, which, you know, which was then unheard saying, and even more unheard now!

MAPSTONE:

It's still more unheard of; you're right!

HEROLD:

It really ran. [laughter] It really ran, too. It was a good machine.

MITCHELL:

It worked, and it was a good machine. It had some flaws which we discovered later, as it turned out, after we had delivered something like five machines.

HEROLD:

Oh, God, the memory! [laughter]

MITCHELL:

There was a memory problem.

HEROLD:

If you put in a certain pattern, it was locked up like a rock. You couldn't do anything. It was just . . . [laughter]

MITCHELL:

The memory became absolutely frozen performance.

HEROLD:

Forzen, it just froze! [laughter]

MITCHELL:

It would freeze. You couldn't even erase the data that was in there, unless you took that code of memory out of the computer and put it on something which would just blast the stuff out.

HEROLD:

It was just . . . jrr . . . just like that! [laughter]

MITCHELL:

And we had customers who were using this machine. We had one at Motorola which was running an automated transistor line. And, you know, we had a panic situation. I remember Bob Beck and this guy who had done the memory chained off a portion of the floor out there and nobody but nobody, you know, but those two guys, were admitted within that chain. But that was, you know, you would die if you stepped over that chain. [laughter] And they worked for something like a week and a half, night and day, on that problem, and finally solved it; and we sent people out in the field to rework these computers that were out, as we were afraid that would happen and we didn't want the computer reputation to be _wrecked. They sent a group down. They fixed them all except one, which was the one at Motorola. And those people said, "You're not going to touch our machine; it's working fine! it's running this line; and nobody gets in touch our machine. It's running twenty-four hours a day, and we haven't had one error, and it's been. . ." You know, by that time it had been weeks they'd been on the thing. Anyway, they ran this computer on that line for something like two and a half errors with no errors at all, nothing, no problems; and finally they wanted to expand the thing to run something like three or four transistor lines simultaneously, and they needed a bigger memory, at which point we worked on the memory. [laughter] But, God, it was panic at that point.

But in any event we got both machines working and I remember the stories of a guy, whom we finally hired, who worked for Bell Labs who bought one of the machines.

HEROLD:

Spinrad. It was Spinrad.

MITCHELL:

Was that Spinrad?

HEROLD:

Yes.

MITCHELL:

Who used to tell the story of how he came. We had the prototype, which we were just checking out. You know, we had problems with it. Everybody has problems with the prototype. And he came in about ten o'clock or something and they were going to show him the computer and something happened. So they said, "Well, let's go out to lunch," So they took him out to lunch at eleven. And when they came back at one, we all--I guess it was Henry and I--worked on that thing all through lunch, madly. When he finally came back at one, we were entering his program in the computer. And, you know, he was astounded. You know, he couldn't believe it. And he still to this day talks about that. [laughter]

MAPSTONE:

I imagine.

HEROLD:

Yeah. Well, we got all the peripheral equipment going, too. We had a lot of fun on it. It was really . . . We did everything in an awfully big hurry.

MITCHELL:

Oh, wow, it was incredible.

HEROLD:

Oh, we just had fun and we didn't know what we were doing.

MITCHELL:

We had fun doing it. That was really the most fun company any of us had ever worked for.

HEROLD:

Oh, yes. We had so much fun. Max would just get so angry with us because we had so much fun. We just couldn't hardly believe it, we were laughing so much.

MITCHELL:

Well, we used to come across these things where someone would say, "Well, here's a great instruction we can live!" And all we have to do is pull out two modules, and put nothing in." [laughter] Wow, you know, that's funny as hell! We'd start laughing and Max would come storming out of his office saying, "All right, you guys, this is a place of business, and we've got to be serious here!" And we'd say, "But Max--" "No buts!"

HEROLD:

Max was awfully good, though, on the technical decisions in stopping us from perfecting the thing. The tendency is to go on and design and design and make it just right, because if really do want to sell it, well then, it should be this way. He'd just get to a certain point, and that's it, that's enough, no more doodling with it, you've got to get it out.

MITCHELL:

You know, we'd have someone who'd have a great idea, and we'd say, "But Max, you know, look, we can do this!" "No," he says. "That design is froze and we're building it as it is. No more!"

HEROLD:

Right. Right. "We want another kind of flip-flop module." "Absolutely not. We've got enough kinds of them."

MAPSTONE:

That's really. . . That's really . . .

HEROLD:

That's somebody who takes it and really says no, and, you know, your heart cries, because you know that you really want to make the machine beautiful, just lovely. You want to make it perfect. But that takes forever, you know, and that limit just becomes non margin.

MAPSTONE:

Yes, with the way the technology is speeding up, you'd never have built them, ever!

HEROLD:

We used to get them out fast, and if they're not quite perfect, well, build the next one better.

MAPSTONE:

Next one better?

MITCHELL:

And the machine, really, I think we did push the state of the computer art, because nobody. . .

HEROLD:

Oh, yes! It was all silicon , I know.

MITCHELL:

And also it was fortunate for the company, because we had no competition. The only machine out that people were using the 160A, which was never designed as a general purpose computer. But it was the only thing in that price and performance area, and so people were using it as a general purpose computer.

HEROLD:

We were the first ones with a silicon computer, too.

MITCHELL:

We were the first ones who came out with an all-silicon machine which was designed for that specific purpose, where nobody else had designed any computers. We had two of them, just covering just a beautiful range.

HEROLD:

Very inexpensive memories. I remember that was eight microseconds, and it was really a good range.

MITCHELL:

That's also--right. And we also had the thing priced right at the beginning. We priced it less when we first introduced it for sale.

MAPSTONE:

What was the price?

MITCHELL:

I think it was $30,000, or it was $39,000, for the 910.

HEROLD:

910? $100,000 for the 920. But it--yeah. $100,000 for the 920.

MITCHELL:

Not initially. The initial thing. . . We boosted the price after we had sold a few. But the initial ones, I think, were $39,000 for the first 9l0, its bare bones.

HEROLD:

We had some real nice features, too. We had a real fancy interrupt system. We had the . . .

MITCHELL:

We had the first interrupt system, the sort that the people are using now.

HEROLD:

We had interlaced cycles field, which was fairly new at that time.

MITCHELL:

Right.

HEROLD:

And a good buffering scheme where input-output, the two buffers were going at the same time.

MITCHELL:

Right. We had a lot of innovations. They came up with just . . .

HEROLD:

_____ we had an input-output where so you could time various things.

MITCHELL:

For that, we were way ahead of everybody, just way ahead of everybody.

HEROLD:

Wide character buffers.

MITCHELL:

And so of course it was a very popular machine. The only thing that was unpopular was that it _____, and also we didn't have all the software out at the same time as the hardware, which is difficult typical of the computer industry as a whole.

MAPSTONE:

Right. Hasn't improved yet.

MITCHELL:

No. But we did get some pretty good software out.

HEROLD:

_____. Yeah, they got the Fortran 4 going, and it ran well.

MITCHELL:

Yeah, and those machines, of course, are still running.

HEROLD:

They were solid, all of them.

MAPSTONE:

Was the 910 and the 920 compatible, just one was a slower system?

HEROLD:

Yes. Yes, well, there were some separate structures.

MITCHELL:

There were traps which would trap on the 910.

HEROLD:

The 920 had the multiply and divide built in whereas the 910, you had to do it by programming. It was deliberately done, actually it didn't cost that much, but it was a way to make come differences.. I think our shop costs were _____. It was just a whale of a selling angle.

MAPSTONE:

How about now if we close it?

[End of interview]