Computer Oral History Collection, 1969-1973, 1977

Interviewee: James Bradburn
Interviewer: Robina Mapstone
Date: February 1, 1973
Repository: Archives Center, National Museum of American History

MAPSTONE:

The date is February the first and this is Bobbi Mapstone and I'm talking to James Bradburn, and we're going to talk about the developments at Consolidated that led up to the development of computers and talk about the first computer center.

BRADBURN:

Consolidated Engineering was originally founded out of United Geophysical, and their product line was two-fold--all having to do with the petroleum products originally--in that they made mass spectrometers and other technical equipment, link detectors, at the same time they got off into a line of recording of oscillographs and ancillary equipment, electronic pickups, and so forth, for the measuring of pressures, the dynamic measuring of pressures and velocities, acceleration and movement vibration, and so forth, used in various structures and in aircraft design. And gradually, as time went along, they got into some--we got into some--at the time I was Vice President of Engineering for Consolidated, this was back in the late forties; this was about 1946, I guess it was--and gradually the line, of course, was improved and made more sensitive. The reason mass spectrometers are with the picture is that mass spectrometers, the output from a mass spectrometer is a series of graphs on recording oscillograph paper, all of which data has to be reduced, and you can produce a tremendous amount of data, but you have to compute the whole thing to get it back into a spectrum of the elements making up the compound which is being diagnosed. So there was an interest right from the start in the mass spectrometer business in computing methods and techniques, and we'd started some work with such organizations as Atlantic Refining and others, in the use of some form of computers to help reduce the data more automatically.

MAPSTONE:

Did they have computing devices at this date at Atlantic Refining?

BRADBURN:

Yes, but these were more semi-analog devices. They weren't digital at that particular time. But, as you know the history of computers in the United States, the digital computer was starting to come into its own. You know, there was the Card Programmed Calculator and other devices which were being used for such purposes. Then, at the same time, of

course, these recordings of oscillographs were starting to be used more and more in the missile business. I'll never forget going up to Fort Laneemee, which is up, you know, near Ventura here, where the Navy had a big installation--and still does, I guess--and they were shooting the first missiles over the Santa Barbara Islands, and the data all came back by telemetry back to the central place, and they had a whole bunch of oscillographs there, and they'd shoot off a missile, the missile would, you know, take just a few seconds of time before it had completed its result and in this period of time they'd get many, many feet of recording oscillograph paper from a number of these different units, and then everything would shut down while one hundred and twenty-five people in one room would reduce the data for about thirty hours.

BOTH:

[laugh].

BRADBURN:

And I said, you know, "What have we created here? We've created a Gargantua here. Who's going to live with this sort of a thing? We've got to do something about it." So this really inspired us. This was the key thing. I can remember that day that inspired me, anyway to start seeing, "Well, how can we reduce the data? We've got too much data. Now how do we get it?" So this got into so-called data reduction, and it led us really--oh, to go back: this was about the time, you know, of the first computer conference in Philadelphia, or the second, by this time. So, we got into this act and got more into it, and we started a project to build a digital computer. And fortunately, right from the start, we made some pretty wise choices in that we decided we'd make it decimal and not binary, by carrying four binary bits for every decimal.

MAPSTONE:

Mhm.

BRADBURN:

And we made it with a ten-decimal device, so the thing turned out as it went on. It was equally good for commercial as well as for data reduction of scientific data. So we started in with this thing at Consolidated, and I don't know what date we're up to now. By the time we got much going on this, it must have been '46, '47. And we were fortunate to get some help through Cal Tech, because two members of the Cal Tech faculty were on the board of directors of Consolidated. This was Lindvall and Bacher.

MAPSTONE:

Can you spell these names? BRADBURN:

L-I-N-D-V-A-L-L and B-A-C-H-E-R. Bacher is still at Cal Tech, and Lindvall, at the moment, I think, is Vice President of Engineering for Deere & Company. But I don't know that--the only role they played was to give us a little bit of some technical support. And so I asked Lindvall one day, you know, who have you got around Cal Tech who can really help us on digital computers, because other universities are vying. "Well," he says, "there happens to be a Dr. Ernest Selmer,"--and I mentioned this to Mr. Tropp--"here, who is a Norwegian, and he has been with Princeton with Von Neumann for a few months, and then he has been up with Paul Morton

MAPSTONE:

Oh, yes.

BRADBURN:

at Cal for a few months, and now he is down with us for a few months." So we got a hold of Selmer, and he came over and consulted for us for a period of time, and played a major part in the initial logical design of the ElectroData computer, as we called the thing.

MAPSTONE:

Did you and Ernest have any contact with Stan Frankel at this point? Was Frankel at Cal Tech at this point?

BRADBURN:

Yes. Stan Frankel was not there yet. I think this was before Stan got there. I think Stan worked for us part-time. And his wife worked for us. And Stan subsequently did develop a--what in those days might be looked at as a mini-version of the thing; in that he was able to do some short circuit--take some short paths here by time-sharing certain components and reduce the thing. He did some work, I think, for Atlantic on that, or it wasn't Atlantic, it was Phillips--I'm not sure. But that was the next step in here, because his work was, more or less, as I recall, tied in, to a degree, eventually with what Bendix did out in this area here in town.

MAPSTONE:

So Selmer had come the Princeton route, so he was familiar with Von Neumann's work and Julian Bigelow's work.

BRADBURN:

Yes, and Goldstine. He was only there about four weeks. But this guy is an absolute genius. There's no two ways about it. He is now Chairman of the Department of Mathematics at the University of Bergen. And I gave Mr. Tropp this. But he also got the

Cal background. Harry Huskey and that group who were up at Cal at that time, so he links in with that, and then with our own people we had at Consolidated. So, we ended up though, with this thing going as an engineering project, and Consolidated at that time was not very large, and they had just finished their second, as I recall, public offering of stock; in those years it wasn't very easy to raise money as it is today on scientific projects, or companies either. But they had just been to the till, as you'd say, to the New York Stock Market through Blythe and Company for a lot of stock, and they said, "Well, you know, we can't go back again." So we had this engineering project going and we'd gotten into a few hundred thousand dollars on the thing, which was a lot of money in those days. You'd multiply it by ten today, I guess. And so we said, "Well, how are we going to carry this thing on? This is important." So we ended up forming the ElectroData Corporation. And we split it off from Consolidated, and this was about--you'd have to look up the details on this, I don't have them here. My recollection is that it was about '49 or '50, somewhere around that time; '50, '51, yes, around that time. By this time we had a working model of a computer.

MAPSTONE:

Mhm.

BRADBURN:

And so then we--so we set out on our own then, with a public offering of stock, and which Consolidated got its share of that issue.

MAPSTONE:

Were you like a wholly owned subsidiary of Consolidated?

BRADBURN:

No. No, not when we split off. They ended up owning maybe about ten or fifteen percent of the stock which was equivalent, at the price we sold the stock, to their investment in this business. They invested, as I say, a few hundred thousand dollars, so they got, in effect, the equivalent of that many shares of stock. This is a matter of record. You could find this out through the Securities and Exchange Commission, or some broker, I guess. I think that will all be available in Washington if somebody wants to just go around over there and find it. So, we went ahead then and built our own, you know, our own organization, which included then our own marketing organization, field engineering organization, manufacturing and engineering.

MAPSTONE:

Well, did you pull people from Consolidated?

BRADBURN:

Yes, we took maybe thirty people from Consolidated, who were the nucleus of this thing, somewhere in that neighborhood, twenty-five to thirty. And we rented some facilitation from them, although by and large we started in renting an old vacant market up there on North Lake Avenue in Pasadena, and that's where the thing got started. And with the money we got from this stock offering--it went so far. And then we got another public offering, in which we got some more money in. But as time went on, we gradually expanded our marketing organization, and it appeared that the machine was quite admirably fitted for use with--in business problems. So we gradually got over, then, into selling it for business use. By the way, our first customer, the first machine we produced, went to JPL: Jet Propulsion Laboratory. And they were a great help to us, you know, in commenting upon its value and its use, and so forth. And this worked fine.

MAPSTONE:

Your first machine was a GP?

BRADBURN:

The first machine was a general purpose machine. It had typewriter input and output, and it was a big drum memory machine, and it had another couple of features, which made it extremely advantageous to people doing this kind of work, in that the drum--[there] were, of course, fixed heads on the thing, but it had what was known later--was called revolvers: that is, the--you take the information off of one head and put it right back on, one tenth of a revolution behind, so you always had this information in one-tenth of a revolution.

MAPSTONE:

Mhm.

BRADBURN:

So you had more rapid access than the once around every 3600 RPM drum. So you could speed up operations of those repetitive ones where you needed to do so which was very helpful in a lot of scientific problems.

MAPSTONE:

Did you build your own drum?

BRADBURN:

Yeah, we built our own drum. Yeah, right from scratch. We built everything from

scratch. There wasn't anything purchased but the typewriter.

MAPSTONE:

Yes.

BRADBURN:

And that was a standard electric typewriter.

MAPSTONE:

Mhm. You used card punch machines?

BRADBURN:

Well, that, that came next. The next thing then was to add a simple, lined converter, taking it from--See, all the card machines in those days, all read everything in parallel. See. They read all the columns in parallel. So you had to take that and turn it around the other way, because all the machines operated in a serial mode, you know. So we handled four bits in parallel in the machine. But then, all the decimals went--of the word then were handled serially. Well, to get from the card over to the--into the serial you had to turn the corners, as it's called, so we had a simple-minded card reading machine, which permitted using a standard IBM card-reader, and then it went through this converter into the machine. And then, of course, the next thing we added was the ability to print out on a IBM big old--oh, those printers that they used with the CPC machine. I think it was a 403, or some such number.

MAPSTONE:

It was a 4-0-something.

BRADBURN:

407 maybe, something like that.

MAPSTONE:

By then it was probably a 407, yes. The first one was 405. It sounded like a washing machine.

BRADBURN:

Yes, well this sounded like a washing machine, too. So, that was added on to it. And then we got involved in a contract for Stanford Research Institute, who had in turn a contract

with the Bank of America to build a big banking machine.

MAPSTONE:

Was this ERMA.

BRADBURN:

This was ERMA. So we built a special drum. We built the drum for ERMA. And we built a tape unit for ERMA. So we got into tape units in the late forties, too, making the first tape unit. So, we built our own mag tape units.

MAPSTONE:

Magnetic tape, not ticker tape?

BRADBURN:

No, we're talking magnetic tape. See, our first machine there, that I've said had a typewriter input, and I should have added, also had paper tape input on it. So we read our programs in from paper tape; and we outputted on paper tape. Then we added this card-adapter, so we could read in from punch-cards and at the same time not turn the information around going output out on the 405,-6, or -7

BOTH:

[laugh].

BRADBURN:

or whatever the number is. 'Cause I don't remember that.

MAPSTONE:

Mhm.

BRADBURN:

But we always had paper tape capability all the way through here, and format control on the printer. Then we went from there to putting mag tape on the machine, because we developed these machines for ERMA. As you'll recall, we built the tape unit, we built the drum for ERMA; Bendix built the electronics through Stanford Research Design, and I think Friden or Marchant built the keyboard devices for it. Stanford Research put the whole thing together, and then subsequently, GE came in and won the contract to make the whole thing and carry it on.

MAPSTONE:

Oh, I was going to say that I knew GE was in there somewhere.

BRADBURN:

But that was a couple of years later.

MAPSTONE:

That was at the production level.

BRADBURN:

Yeah, but by this time they changed the whole thing around, and made it a different machine and NCR got in the act, in building the machines for GE that went with ERMA. Then the whole thing was thrown in, because it wasn't a very good concept.

MAPSTONE:

[laughter].

BRADBURN:

So ERMA was a long time--If you want to get stuff on ERMA, get a hold of—

MAPSTONE:

Weizenbaum?

BRADBURN:

Bob Johnson, who ran the thing for GE, and I later hired him; Bob Johnson, who is Vice President of Burroughs.

MAPSTONE:

Currently Vice President?

BRADBURN:

Currently, yeah.

MAPSTONE:

Burroughs out here?

BRADBURN:

No,

MAPSTONE:

I see.

BRADBURN:

in Detroit.

MAPSTONE:

In Detroit.

BRADBURN:

He can tell you more about the ERMA thing from the GE side of it than probably any person.

MAPSTONE:

Does the name Weizenbaum mean anything to you?

BRADBURN:

Not to me, no. I know the guys at Stanford Research that were all on it.

MAPSTONE:

Yeah, I think he was outside, on a contract.

BRADBURN:

Jerry Noe, N-O-E, he was up at Washington or someplace up there, I think, is the guy who probably knew more about it technically about it at SRI than about anybody. So anyway, so we went ahead and got it to the point where we had a card machine and a printer output and tape, and it was a pretty complete thing. It drew a lot of kilowatts and filled a lot of space, but it did--it did then what a mini-computer will do today.

BOTH:

[laugh].

MAPSTONE:

It was not exactly a mini-computer in its time?

BRADBURN:

No, it had a lot of other features. It was about two-hundred kc machine, I guess. But we had all kinds of safe--we were bugs on reliability in those days, so we had a lot of built-in stuff; so you could, in a test mode you could increase--we had a--just put an ordinary oscillator in there, and in a test mode you could check all the validity of all your logical circuits at higher frequencies than they normally would operate at. At the same time, though, you could reduce the voltage on all the tubes, and, if it passed both tests, the probability of having it conk out then during normal operations in the next x number of hours was pretty low. So, it was a very reliable machine in that sense.

MAPSTONE:

Were you influenced at all by the group at Northrop?

BRADBURN:

No, not at all.

MAPSTONE:

You had no—

BRADBURN:

We were influenced in the following way. The group at Northrop became CRC--Computer Research Corporation--and we were pretty close friends. We didn't--The machines were different in their design, and I forget now, to be honest with you, what the logical difference was. But CRC ran into the same problem, I guess, a lot of other people do, like we did eventually. They ran out of money to really go ahead, because, when you start leasing computers your cash-flow and investment requirements are so multitudinous that you are in a difficult position to last, unless you've got access to a lot of dough. And, also, we were always very conservative in our accounting, in that we wrote off all our engineering and development expenses instead of deferring them and going--taken to the cleaners later on, you know. So CRC sold out to NCR, and NCR's arrangement with them ended up that all the top people quit. They didn't like the way it was handled. So we watched this with great interest, because about a year and a half later we ran out of money. And--we had borrowed money from--we had--were just in the arrangement of

working out a very feasible system with Allstate Insurance and Security Bank. But, at the same time, Burroughs came along to us and offered an opportunity to sell out to them and become their electronic computer division for them. So, about 1954, I guess was the date, or somewhere in there--'55, we became a wholly owned operation; as a matter of fact, we dissolved the corporation and we became a division of the Burroughs Corporation. And I became a Vice President and General Manager of the ElectroData Division, which handled all the computer operations for Burroughs. That arrangement continued until 1960, at which time--shortly before then--John Coleman, who had been president, passed on of a heart attack, and Ray Eppert became president of Burroughs; and he had a different concept of how Burroughs should be operated. And he--we dissolved ElectroData Division as a division, and he--and I became Vice President of Engineering and Manufacturing, in which the Electrodata Division was just one division of that division, and the marketing group became part of marketing. So that's a whole story by itself.

In the meantime we had started to develop faster machines and bigger machines in what was called the Burroughs 220, and then on in to develop the 5000, the B5000 machine, which was a development--which is the basis of--all their business today is based on the B5000 concept. And that came out, you see, towards the end of, oh, about 1960 now. The interim machine, the 220, was really an upgraded, earlier ElectroData type machine. It was faster; it used some special circuitry, different kind of tape drives, faster tape drives. But, essentially it was the same type of architecture that the original machine, the 205, was.

MAPSTONE:

Let's cut it back for just a minute.

BRADBURN:

Yeah, ok. So that brings us up to that time. So backtrack if you will.

MAPSTONE:

Firstly, did you get a name, number, any kind of identification on your early machine?

BRADBURN:

Yeah, it was the big--it was the 201.

MAPSTONE:

That would be—

BRADBURN:

The initial was the 201. CEC--well, it had a--CEC always used a double digit number, like, I think it was the 20-201, and then when it became ElectroData, we dropped the 20 dash part and kept the 201, because the whole sequence of phonic catalogue numbers in C's, you see, all started out with the first digit before the dash, or the first two digits before the dash. But the product tightened designation and the last three was the specific product, you see. Like an oscillograph, was a 5-201. 202, and so forth. But the 5 were oscillographs. So we handled, I forget, maybe it was 21-201, I don't recall now.

MAPSTONE:

I had a reference that said 30-201.

BRADBURN:

Well, all right, it could have been 30. I'm sorry.

MAPSTONE:

So, after the first one—

BRADBURN:

But then, the 202 probably was with the paper--card reader-- card equipment handed on it and then the 202 had a--203 had some--was the first of the tape units, and the 204 was a faster complete alphanumeric instead of alpha. The first was a numeric card equipment, and then alphanumeric card equipment. So we got up to the 205, [which,] I think, was the highest number in that group. Then the 220 started off with the, with just a faster, bigger machine.

MAPSTONE:

Somewhere along the way you must have got into a transistorized unit, too.

BRADBURN:

Well, yeah. We got in very early in the transistorized. We were probably the first machine to make a transistorized device. And this was a--this was just tape to printer alone, with complete format control. And this must have been, oh, someplace in 1957 or 8, I think it was. And this was a pretty sophisticated thing, in that we'd take the standard tape off of the, the computer and put in separate format information into the, into its own computer, if you'd call it that. I don't know what else you'd call it. So we could end up making printing in the type of format that you wanted.

MAPSTONE:

Oh, I see.

BRADBURN:

Yeah. So that's a--We'd leave the computer and all its stuff and have 'em to format the output of the thing. And, of course, the obvious reason for doing this, you don't do it today, you do it in the--more in the program mode, if you want. You write it into your program, and the computer handles it. We didn't have high-speed memories then, so it was simple to take the tape off the tape unit, and just put it on another tape unit, and do your printout separately. The faster machines coming later on, these being earlier drum machines, the faster machines as we got into core and what-not, permitted the ability to do it right in the whole program and output as you went on the fly. But you find out, even today, there's a--there's tape-to-printer output, you know.

BOTH:

[laughter].

BRADBURN:

Because they can't isolate it in some cases. But this is probably as early a fully transistorized machine as anybody built.

MAPSTONE:

Did you get into things like government contracts?

BRADBURN:

No, never.

MAPSTONE:

You were purely commercial?

BRADBURN:

That's, that's right. We decided we'd stay completely commercial. We never got a nickel from the government. We stayed completely commercial, but, by the same token, we had to supply all the funds, so that became a problem back in those days, which, today, I don't think you'd quite face the same way.

MAPSTONE:

And you were into the leasing business until—

BRADBURN:

Right from the start. And that's where the problem lay from the financing point of view. We were growing so fast we couldn't get enough revenue. And if you analyze that economically, there is a rate of growth which you find it very difficult to make profits. Of course, the industry was growing then.

MAPSTONE:

Oh, yeah.

BRADBURN:

We actually sold as many of those machines, of course, we sold more per salesman than IBM did.

MAPSTONE:

[Chuckling:] Did you really?

BRADBURN:

The only problem was "per salesman"; see? Where we got ten salesmen, they had 22,000 [laughter], see, so it was a little bit difficult to show it.

MAPSTONE:

Were you selling cross country, you know, across the country?

BRADBURN:

Yeah, we had, we opened an office early in the fifties in New York in the Chrysler Building, so we went into that market. I think one of the earliest machines went to Babcock and Wilcox.

MAPSTONE:

So you went into regular data processing?

BRADBURN:

Yeah, that's right, yeah. Yeah.

MAPSTONE:

Early on, in effect.

BRADBURN:

Well, we built up a pretty good group of early programmers and what not, and changed all the--The initial group was highly mathematically oriented individuals. And then, subsequently, of course, everybody got in more application type people.

MAPSTONE:

Yeah.

BRADBURN:

So we had, we had our--then we had our own service people. So the thing gradually grew. We finally grew out of that early market place and built a new building in about 1954 out on Sierra Madre Villa Avenue, in Pasadena. And that's where Burroughs found us when they bought us out.

MAPSTONE:

Well, let me see. So who else, apart from IBM, was your competition?

BRADBURN:

Well, if you look at a list in those days there were a lot of smaller companies moving into the act, and subsequently came out, like ALWAC and—

MAPSTONE:

Librascope?

BRADBURN:

Librascope were not in the same--no. They built more or less just parts of things, if my memory serves me correctly. Underwood tried too. And had a very sad situation. They were Elecom, and Underwood bought them out, and then Olivetti bought out Underwood, and the whole thing fell down the drain. But it looked for a while, they would. NCR never was too much of a competition. I would say our main competition, of course, was--that we always bumped into--was IBM and UNIVAC, Sperry--what is it? It's Sperry now. Remington Rand, I guess, before it became part of Sperry.

MAPSTONE:

What about price? Were you competitive in the prices?

BRADBURN:

Oh, I think so, yeah. It's hard for me to say today, but we provi--we were. I would just say we were competitive. I don't know what else to really say. You know, you can't make a yardstick now on something like that. Now, we priced what to a lot of people appeared very high over manufacturing costs, but not as high as a five to six-to-one, like IBM prices; which gave us some advantage. But then their manufacturing costs were lower, so we had to, we had to work in the range of something like three, which you have to do if you are going to provide service, programming and application work.

MAPSTONE:

Were you providing your own programming, too?

BRADBURN:

Oh, yeah. But it was all machine-programming now. If you think back in those days, there wasn't any FORTRAN or special language. It was all machine-programmed. We programmed in machine language, not in a higher order language.

MAPSTONE:

Did ElectroData get into the writing of programming languages, assemblers, compilers, this kind of thing for their machines?

BRADBURN:

Yeah, but that was when we were part of Burroughs by that time. In the history of the evolution of the thing, why, the first thing, of course, was getting into assemblers. The higher order languages didn't come along, nor were they needed until you got about into the B-5000 class of machines, where it was pretty difficult by now to start trying to write that thing in machine language because it's not that kind of a machine. But that was really outstanding in its period of time, was the B-5000.

MAPSTONE:

You mentioned earlier about the whole concept changing.

BRADBURN:

Well, you see, the earlier concept was all the von Neumann stored program stuff. Some of the Cal thinking had gotten in through Selmer probably, and so forth. But it was a

pretty straightforward stored program machine. We had one other little advantage in here that most of the machines of that time, and the IBM 650, didn't have. Ant that was, we had, as I said, these revolvers and they didn't have--the patent department, well, Tropp can tell you all about that. Ask him. He can tell you more about that. As it turns out, we had a lot of common information. Ask him about that if you write that part of the story of the revolvers. Because he was at Iowa, and the guy told us was also Iowa and—

MAPSTONE:

You had a contact with Berry, is that right?

BRADBURN:

Oh, Cliff Berry worked for ElectroData. He was the mass spectrometer guy, see.

MAPSTONE:

He's mentioned as being at—

BRADBURN:

And when they got into the revolvers, and IBM questioned the validity of the patent, we says, "No, no way." Because Berry says, you know, "I've seen the guys working on a capacitor revolver-type thing and that way preceded that." IBM went the 12,000 rpm on their 650, in order to get away from that, to cut the access time down. We got the access time down by just putting our heads around and taking off a one and reading in the next one, you know.

MAPSTONE:

Hm.

BRADBURN:

But, there was another advantage we had; and that was, we had additional registers known as a B-box that entered into our machine, so you could store added factors or additions in here to modify instructions or to update instructions or modify the numbers, particularly on repetitive programs.

MAPSTONE:

So with the B-5000 the concept changed?

BRADBURN:

Yeah, well, that was an entirely different architecture. By this time in the evolution of computers we tried to get over into where we wanted to do more--like programming, you know. Or, if you ran it on a program, and some guy has something else he wants to do, can he come on in and do it and not have it interfere with the other? Because if you try to plot out the timing of all these devices on a computer, you know, even some of the 360's, for goodness sake, the central computer is sitting there eighty percent of the time, you know. And other devices, you know, it isn't an even flow. It's as bad as the traffic on the freeway. It isn't even all the day, you know. There's parts you could have used that aren't used when others are fully loaded. So the attempt was--in this machine was--to equalize the load throughout the whole equipment. And we got in the concept of push-down stacks and all this stuff, so we could move from one program to another and do it simultaneously. Do a lot of simultaneous work. Of course, it was fully transistorized and a lot faster, and used more memory, although it had some drum on it, too. The drum part of it, and later the disk, was so you could store your program in segments and have them pulled in and not tie up your ordinary store.

MAPSTONE:

Like backup?

BRADBURN:

Not just backup. No, backup is on the basis of where, if something fails, you can, you've got it stored some place else. And you can pull it in, in that sense. I don't want to use the word backup. No, rather the way you segmentise your program is, you run through parts of it and you got it in core for rapid access, when you're about through with access you dump in another bunch and then you go through it. They're starting doing it today with this page memory. It's the same old concept that's been kicking around. People don't call it that back in the fifties, you know.

MAPSTONE:

It's strange how the concepts recur with a new name and a slightly more glamorized package.

BRADBURN:

Yes, that's right. Several people contributed to this--I know at least three people I can talk with also. They invented the push down stack on the B-5000. They all worked together so we'll give them all credit for it.

MAPSTONE:

Talking about giving credit. What about the patent situation? Were you patenting as you went along?

BRADBURN:

Yeah, we patented as [we] went along and that's, of course, where we found--into the discussion we got through with Berry and all this stuff. We were fortunate. We never had any lawsuits on our hands. We finally ended up with enough patents of our own to make a deal with IBM to get complete cross-licensing, so we were licensed under IBM patents, and they were under ours.

There were in those days a couple of patents which were outstanding, but the volume guys like IBM and UNIVAC who were using the same patents... the people who owned the patents were fighting with them and we just went along our own jolly way and so we never had any patent fights. But we had enough of our own to do trading with other people. Don't ask me what patents we had. I can't remember them. [laugh]. But we had enough to do it.

MAPSTONE:

Tell me, how can I find out about the patents, you know, that your company patented?

BRADBURN:

Our Patent Attorneys in those days were Christy, Parker and Hale in Pasadena, in what used to be called the First National Bank building, I think at 555 Colorado Street. But I don't know what they are called now. The building name has changed.

MAPSTONE:

Christy, Parker and Hale?

BRADBURN:

Yeah. And Christy died, so it may have been just changed to Parker and Hale.

MAPSTONE:

So I should try to get onto either Parker or Hale.

BRADBURN:

Yes, if they are still alive and if they're still in business. Who took it over, I wouldn't know.

MAPSTONE:

Otherwise, I suppose Burroughs again?

BRADBURN:

Well, I suppose so, yeah.

MAPSTONE:

Because they would have picked up all the patents.

BRADBURN:

They have the study of the patents, so Burroughs in Detroit would know about it. But the patent attorney at Burroughs there has since retired, and I don't know where he is anymore. His name was Kressler, K-R-E-S-S-L-E-R. We did all our patent work through this firm and they were almost like part of us.

MAPSTONE:

How about talking about some of the people who were involved in the early work and whom maybe I should be trying to contact.

BRADBURN:

Well, you know, Tropp might try to dig this up, too, and that's why I'm trying to get you to get these names from our friend at Burroughs, see. L.P. Robinson was the chief engineer in those days. J.B. Rice, whose name I gave you was the manufacturing guy. Duncan McDonald was another one. I gave you his name. He's in the beach down here.

MAPSTONE:

Right, I haven't gotten to him.

BRADBURN:

No. Some other people are trying to get to him, too, and they tell me they can't find him. Really--those are the main guys. Ed McAllister was marketing manager in some of the early days. He's with Burroughs now. He was with me at RCA. We left RCA about the same time. I don't know--those are the top level people. George Holmes was the comptroller and he lives up in the Kinaloa Range area in Pasadena. He might help you out. I don't know. George Holmes, H-O-L-M-E-S. But he wasn't technical. Bobby Alexander was Personnel Director. He might be able to think up some more names. I don't know where he's at, I've lost track of him. But the two engineering people at the top level were McDonald and--Lloyd Cali, who now is with Burroughs in Detroit, was also one of the old time engineers in that group. Maybe he's kept track of some more people, I

don't know.

MAPSTONE:

One of the sort of interesting things about your company is the fact that it is probably the only one on the West Coast that I can think of that didn't sort of come from that--or through that Northrop influence.

BRADBURN:

Robert B. Forrest, editor, at 94 South Las Robles Avenue, phone 681-6486.

MAPSTONE:

He must have just moved his local office or something.

BRADBURN:

I don't know. OK. I'm open to questions.

The only thing I would say that you've got to think about in those days, we had to not only develop the architecture, but we had to develop the circuitry, and we had to develop the hardware. Because the early problems that we used to have with reliability when you deal with hundreds of thousands of connections which no one ever dealt with before, it meant you had to certify every soldered connection. You had to justify your whole soldering techniques. Now later on, of course, people learned how to do this because of missile development, you know. And techniques were really testing those things out. But at the start nobody had any decent connectors, for example. And so we were limited in what we could do there. You couldn't get a decent keyboard for input, so you had an old typewriter, and you had to hang some old magnets on the bottom or it. So the reliability of all these devices had to come along as we went along with it. When the very first of the old memories were just under development, we didn't want to get into the situation of those cathode ray tube electrostatic memories because they were on the way out just about when... shortly thereafter as people shifted over to cores. But cores hadn't gotten going. So the best we had to work with was drums and trying to speed them up. And disks, to a degree. But the drums seemed to be a better answer than the disks, although subsequently, of course, disks proved out pretty well.

MAPSTONE:

So you actually didn't do any work in the disk field?

BRADBURN:

Well, we did at ElectroData, at Pasadena, at ElectroData along about '58 or '59, because it

became pretty evident that any of he moving arm disks of that period were very, very unreliable. And the maintenance costs were eating them up. This was before the advent of the 2311. And even the IBM ones were highly unreliable. So we built them totally enclosed, a head per track, big disks, at Burroughs.

MAPSTONE:

By big you mean?

BRADBURN:

Five, four--I'm talking about they ran on a horizontal axis and they were about thirty inches in diameter. But they ran on a horizontal axis, and they were all totally enclosed. And the head per track, we had no moving parts. And this became really the workhorse that made the 5000 into the 5500 and subsequent machines, because it provided a large amount of ready access data so the program could be moved in mass, en masse, you see, into the core memory for rapid processing. And you could dump stuff out of it and bring it back later on and---well, you know, whatever you want to call it, paging or... they've got a few more names today that they like to use. It was block transfer, I guess, is as good a term as anything. That's what it amounted to. The block could be a page or a group of words, or whatever you want to identify it by.

MAPSTONE:

How about the east-west battles, or agreements or disagreements or philosophies. Did you get into this at all?

BRADBURN:

No. We didn't really notice it. We had a small amount, you know, like is involved in any organizational thing, where the big military development programs for Burroughs was Paoli and they seemed to think that they knew all about them and that we didn't know anything about it out at Pasadena. But we argued those things out. Both groups were quite capable, so there wasn't really anything to be gained in that argument.

MAPSTONE:

I suppose this was predominant in the aircraft business where they were building guidance machines. There are two schools of logical design. You know the East Coast block diagram approach and the West Coast Boolean algebra logical design approach.

BRADBURN:

Oh, I see what you mean. Yeah, that's true. We were proponents of getting all the logic, particularly on the B-5000 was written in Boolean algebra.

MAPSTONE:

Oh, it was.

BRADBURN:

Yes, it was all simulated, and checked out in time on some of the best, fastest machines we could get a hold of at the time. I think we used one of the fast Philco machines, they built an earlier one there, or one of the big UNIVAC machines. So we could prove out every program step before we actually built the thing in hardware. It was quite a step in those days. But the whole logic of the machine was worked out in Boolean algebra. And then we had some of the earliest design automation. I don't mean design automation in the simple sense of just blowing up a parts list and splitting them up in orders like a lot of people call design automation. But the machine itself was designed by virtue of the logical guys writing Boolean algebra equations, and then the design automations pulled that together and actually produced block diagrams.

MAPSTONE:

Mhm, yeah.

BRADBURN:

Rather than going to block diagrams and then working out there what the circuitry is going to be.

MAPSTONE:

Yeah.

BRADBURN:

So this was some of the first work done, I think, at ElectroData, was involved in using that kind of an approach to the problem.

MAPSTONE:

Was that used on the earlier machines, too?

BRADBURN:

No, no it couldn't have been. We didn't have any machines to simulate.

BOTH:

[laughter].

BRADBURN:

You know, this was an evolutionary type thing. Because you had to get faster machines to run this on. Because you may have to go through thousands of program steps to check out one program step with a new machine.

MAPSTONE:

I was thinking more about ... again, back to the Northrop group, you know they started on, Floyd Steele seems to be the father of that approach on the West Coast. And his own machines, the MADDIDAS, were designed that way, and I wondered how early in your—

BRADBURN:

I really don't know which guys came with which, and which guys used it. All I know is that when we got into the design of the B-5000, we approached it entirely from the point of view of using, you know, page after page of Boolean algebra equations, and to solve the logic, and then that was dumped into the computer, which in turn cranked it out. And then we checked the whole thing, you know, for timing and other characteristics here on some of the very fast machines by just running time on the machine.

MAPSTONE:

We're just about to run out of tape.

BRADBURN:

Oh, ok. Well, we're just about to run out of time, too.

MAPSTONE:

Before we run out, can you think of any of the more interesting early customers who might be worth mentioning?

BRADBURN:

Well, JPL was our first one up there. They were a very good one. And they, of course, became customers subsequently, too, as we produced faster machines. And they, being right near by, their critique was very helpful to us because, you know, you needed fast feedback, and you could get it by running up the canyon a ways in Pasadena.

MAPSTONE:

[laugh].

BRADBURN:

So they were some of the first ones. Allstate Insurance was a great help to us because they were--that was a real solid business approach to the thing because there were working policies and what not. And they had a very good group of people who were applications-oriented, and their critique of the machines and what they could do were very helpful to us. I mentioned Babcock and Wilcox. They were one of the earlier ones, and I forget now what they used it--I think partly in design more than anything else. I don't know, I guess some of the oil companies--I forget which one now--not Sun Oil, it was in the Philadelphia area down there, no, it's--it was Mobil Oil.

[END OF TAPE]