An Interview with

ROBERT E. MUMMA

OH 73

Conducted by William Aspray

on

19 April 1984

Dayton, OH

Charles Babbage Institute
Center for the History of Information Processing
University of Minnesota, Minneapolis

Robert E. Mumma Interview
19 April 1984

Abstract

Mumma describes National Cash Register's (now NCR) early years in the electronic computing industry. Mumma went to work for NCR in 1939 in their newly formed Electronic Research Department. Before the war he designed gas thyratron tubes for use as decimal counters in an electronic calculator, a working model of which was completed before the war. Mumma discusses the contact NCR had during this period with MIT and Harvard, and reviews some of the early research projects and personnel at NCR. He describes in guarded terms work NCR did before the war for NDRC on a secret communication system and during the war on a high speed counter for measuring muzzle velocity of cannon shells. He recounts how war-time work on cryptanalytic equipment took all the company's effort, and how this shaped company policy resisting government contract work after the war.

The second half of the interview describes NCR's move into commercial electronic computing in the 1940s, 1950s, and early 1960s, with such products as cash registers with punched tape, accounting machines with electronic multiplier, high-speed printers, bar code readers, point-of-sale terminals, and magnetic ink character recognition equipment. Mumma explains how NCR considered purchasing the Eckert-Mauchly Company prior to its acquisition of Computer Research Corporation, as a way of entering the computer field. The division of labor between NCR-Dayton and the NCR-CRC division are considered, as are the difficulties of promoting, developing, and marketing electronic technology in the mechanically-oriented environment of NCR headquarters in Dayton.

ROBERT E. MUMMA INTERVIEW

DATE: April 19, 1984 INTERVIEWER: William Aspray

LOCATION: Dayton, Ohio

ASPRAY: I'd like to start by asking you if you could tell me in a few minutes how you came to work for National Cash Register and then something about your career with them?

MUMMA: Well, I came to National Cash Register in 1939. The main reason was because I used to work for Joe Desch. I had started working for him back in 1932-33 at General Motors Radio and later for him at Frigidaire Corporation. In 1938 he went to National Cash Register Company to set up an Electronic Research Dept. under Col. Deeds. A year later, I left Frigidaire and went to work for him at National Cash Register Company. I was there for thirty years up until 1969. Mr. Desch put me to work on electronic computing and in one year we made a device that added and subtracted using tubes, but we wanted to make something small. We made our own tubes. We used gas thyratrons. We wanted to get the size down. We could count up to a hundred thousand bits a second with the gas tubes which is not as fast as you can go with high vacuum or solid state. That was pretty good. For good reliability we stayed around between ten and twenty thousand bits per second on those. We also counted in the decimal system at that time. We didn't go into the binary system. I felt that the decimal system was easier because you didn't have to transpose going in and didn't have to transpose coming out; you just kept the whole thing in the decimal system. Of course, nowadays it's much easier and things are more compact. In those days, that was the way to do it. So we worked in the decimal system in all our computing work.

ASPRAY: You used decade counters of some sort?

MUMMA: Yes, ten tubes in a counter with an eleventh tube for transfer. That's what we used for that first job. We had two or three denominational orders in that first counter. It was on a rack and panel about six feet high. We had a patent interference with that one right away with IBM. We came out pretty good on that one.

ASPRAY: Could you tell me about that?

MUMMA: Well, I don't know much detail about it. We went to New York and spent several days taking depositions. I forget right now how many claims we knocked out, but it seems to me it was ten or eleven claims out of their original claims. They were using a cathode ray type device for counting. Ours was entirely different from that. It was decimal banks of tubes -- plug-in racks. So, we did knock out about ten or eleven of their claims. The better ones as far as they were concerned. I think we cross-licensed after that on those claims.

ASPRAY: This would have been what year?

MUMMA: Well, about 1940 I guess. Before the war.

ASPRAY: Do you remember any of the people from IBM that were involved in their work?

MUMMA: No, no I don't. I have the patent here, of course. I could look it up and see if there's a reference. It's patent number 2,404,739 and it was for a calculating machine. It was filed July 18, 1940 and it was issued July 23, 1946.

ASPRAY: Okay. I can check that then when I get back. Let's go back a little ways before this. Until Col. Deeds set up this...

MUMMA: Electronic research.

ASPRAY: Electronic research, there had been no electronics in NCR?

MUMMA: No, there had not been any at all. They had an electrical engineer but he was more interested in motors and this sort of thing. No electronic work being done before that.

ASPRAY: Can you tell me why Col. Deeds felt that this would be a good idea?

MUMMA: Well, he felt that there would be a future in electronics. He felt that if NCR didn't get with it they would lose out. Col. E.A. Deeds was a farsighted individual and he did a lot for NCR during his tour of duty there. Another man, Charles E. Kettering pushed Col. Deeds into this decision. Both of these men were very influential in getting electronics started at NCR.

ASPRAY: Oh, Kettering. Did Col. Deeds mention any particular facts or devices or discoveries that suggested to him that electronics was going to be the way to go?

MUMMA: No, no he did not as far as I know. You see, he made his individual arrangements with Mr. Desch who had already been there a year by the time I got there. I didn't hear a thing about what he told Mr. Desch, I really don't know. The only thing he mentioned and the only background I had to work with was the Wynn-Williams counter. I don't know if you're familiar with that, but Wynn-Williams had done some work on pulse counting. But he hadn't arranged it in any denomination or he hadn't done anything like that. I think he just made a string of thyratrons that would ignite in sequence in response to voltage pulses.

ASPRAY: What had Mr. Desch done for the year before you came to work for him?

MUMMA: He had already been working in making small tubes. And he was also working with these circuits. I think he had developed a little counting circuit at that time; but they were having some trouble making them work real well. We found out of course in using gas tubes that there would be a problem with the inductance and the capacitance in the wiring, when you cause the tube to conduct it would self-extinguish. It would just go into oscillation and if you didn't maintain the voltage on the control grid it would just go out. In other words, if you would hold the control grid up at the firing potential, the tube would oscillate. This happened because we kept the current in the tubes very low in order to make the tube extinguish very rapidly and be able to use them in fast counters. So we had to develop a system for stopping that oscillation -- which we did. When we got that stopped we could make the tubes operate as

counting tubes and they would maintain conduction.

ASPRAY: I see. Had anyone else joined Mr. Desch before you joined him?

MUMMA: Oh, yes. Several people.

ASPRAY: Can you mention some of the more important people that worked with him?

MUMMA: Louis de Rosa was one. He's passed away by this time. He was there. Larry Kilheffer was another that was there. Then we had Mr. Cone, he was the glass blower. Of course, Mr. Desch was a very good glass blower in his own right, but he did hire Mr. Cone to help make the tubes. We also had some technicians. I just don't remember their names. We also had a toolmaker.

ASPRAY: That's fine.

MUMMA: It was a very small group.

ASPRAY: After you joined were their some additional people added to the group also?

MUMMA: Oh, yes. We had additions from time to time. We had Frank Bucher and Vince Gulden added to the group. A man by the name of Louis Sandor came in and then we began to add draftsmen to the group. Ed Carey came in as a draftsman. Later a fellow named Coombs came in. He was in the group for awhile. He went to ERA finally.

ASPRAY: All right. So after you came how did the work proceed? What did you do and what did the group do?

MUMMA: Well, I don't remember in too much detail what each person was assigned. I know my assignment was to

make a digital counter with electronic tubes. We preferred gas tubes at that time. I did work some with high vacuum tubes, but we used gas tubes in my project. In this first counter, by the way, we did not use the miniature tubes. We used the larger 884 and 885 tubes. These were heated cathode gas tubes or thyratrons. These tubes were the same except that the 884 tube had a 6.3 volt heater and the 885 tube had a 2.5 volt heater. The miniature tubes we used were made in our laboratory and had 2.5 volt heaters. It was my opinion at the time that 2.5 volt heaters would have a longer life than the 6.3 volt heaters. I connected these thyratrons in rings of ten tubes in such a way as to cause them to conduct sequentially in response to electrical pulses. As each tube would conduct the preceding tube would be extinguished. The number stored in the counter could be identified by observing the glow in the conducting tube. Later electro-mechanical indicators were developed. Also, a tube was added to these ring counters to generate a transfer pulse for the next higher denominational order counter. For this application I used a circuit that would cause the transfer tube to conduct and immediately self-extinguish.

ASPRAY: The main project of this group, though, was to build this machine? Is that right?

MUMMA: Yes. To build electronic devices that NCR could produce. That was the idea. Something that we could produce. I had an idea of a special purpose machine to do a special job. I didn't conceive at that time the general purpose computers as they have today.

ASPRAY: What sort of special purposes did you envision?

MUMMA: Well, machines that would, first off, add and subtract. Later on we wanted to multiply and divide. Remember in those days they had the Marchant calculators and all the multiplication was done with very slow laborious gear- driven machines. None of the mechanical machines at NCR would multiply. The only way you could multiply was by using repeated addition, manually manipulating it on the keyboard. There was no multiply key you could press. We wanted to get into multiplication; that was the one thing I was pushing for very hard. But the first machine we made just added and subtracted because that was the easiest thing to do. We had that model running within one year -- about 1940.

ASPRAY: That means there were subsequent machines also?

MUMMA: Oh, yes. I laid out the machines to add, subtract, multiply and divide. I worked on that machine up until around 1942, before the war. I didn't get the division finished before we stopped to go into war work. But everything else was completed. We demonstrated it. In fact, I do have a sheet here that could give you some dates and that sort of thing.

ASPRAY: Yes, that would help.

MUMMA: O.K. This data was used in the trial in St. Paul in 1970 and 1971 in which I was hired as a consultant by Minneapolis Honeywell.

ASPRAY: Right. In the Honeywell-Sperry case?

MUMMA: Yes, that's right. To contest claims in the ENIAC patents. As I understand it, we did eliminate quite a few of their claims with it. The first add-subtract calculator model carries an NCR Model #3566. This electronic calculator is covered by two U.S. Patents #2404697 and #2595045. The earliest patent was filed last and has only 3 very general claims. The second patent was filed first and has 136 claims. I started work on this first electronic calculator April 12, 1939. I had the model running with stepping switch indicators and using 884 thyratrons by August 15, 1939. It was demonstrated to Carl Beust, J.S. Compton, L.A. Kline and J.R. Desch. The first three were Patent Department people at NCR. The second electronic calculator, which could add, subtract and multiply carries NCR Model #3754. This electronic calculator is covered by U.S. Patent #2442428. The proposal for this calculator was put together by December 18, 1939. A proposal for division was put together by January 9, 1940. The circuit layout for addition, subtraction, and multiplication was completed by March 5, 1940.

ASPRAY: Would there be planning documents for these someplace at NCR?

MUMMA: There should be. I don't know. Mr. Gene Kenesh has charge of all the records for NCR.

ASPRAY: I'm seeing him this afternoon.

MUMMA: I have, of course, all the blueprints of the machine here. I could lay them out for you. Let me check and see if I have them. I've got marked down here patent book no. 6289 if that means anything to Gene Kniess.

ASPRAY: At this time did you know about the work that was going on at Bell Labs by George Stibitz on relay calculating?

MUMMA: Yes. I was familiar with that. And I also saw another machine that they had up at Harvard.

ASPRAY: That Howard Aiken built?

MUMMA: Yes, that's right.

ASPRAY: Had you gone to visit these places?

MUMMA: I've seen the places, yes. I'm not sure I saw them before we started this machine, but during this interval, of course, I was interested in that field. We went around to see what was going on in the area.

ASPRAY: Did you see anything else? I don't know of anything that you might have seen unless there were differential analyzers.

MUMMA: I knew about that because we had an arrangement with MIT.

ASPRAY: I was going to ask you about that next. Can you tell me something about that arrangement?

MUMMA: Well, Mr. Desch would do a better job than I would because he was in charge of the electronic effort at NCR. I'm trying to think of the man's name up there at MIT. Did Carl Rench give you the name?

ASPRAY: He wasn't familiar with this. Sam Caldwell?

MUMMA: Yes. Sam Caldwell. He was our contact man with M.I.T. I remember him. His boss was a professor.

ASPRAY: Vannevar Bush?

MUMMA: That's the one. Vannevar Bush.

ASPRAY: So you had dealings with both of them?

MUMMA: Oh yes. I knew them both.

ASPRAY: Can you remember any advice that any of these people gave you? I understand that Aiken, in particular, was brought in as a consultant.

MUMMA: That was later. Yes. Nothing that Aiken brought in helped us any. We didn't get the concept from him. MIT was pushing the differential analyzer pretty strongly.

ASPRAY: At MIT?

MUMMA: At MIT. I don't think they were too much help for us on the electronic work. I think some of the other people did some experimental work for MIT. They would do some work for us up there too. It wasn't any of my work

that I remember. I remember talking to Caldwell, but I don't remember about anything of any great consequence that we discussed.

I want to finish up my description of this second electronic calculator NCR Model 3754. Let's see, I am trying to see when I demonstrated this electronic calculator. The operation of this electronic calculator was described 7-17-41. I see that this information was taken out of my NCR log books. I witnessed the work 10-28-41, 11-29-41, and 3-31-42. I demonstrated this electronic calculator Model 33754 on 4-24-42.

ASPRAY: This was the one that did all four arithmetic functions.

MUMMA: Only three arithmetic functions, addition, subtraction, and multiplication were checked out and made to function correctly. Division was wired into this electronic calculator along with a quotient accumulator or adder, but was never checked out and made to operate correctly due to the pressure of work we did for the war effort.

This electronic calculator model was displayed at the recent NCR Stockholders Meeting. Were you at this stockholders meeting?

ASPRAY: Yes I was. I saw the tubes for it.

MUMMA: Well that big machine was the machine I actually built. That is the one we took up to St. Paul for the Honeywell-Sperry trial. I tuned it up and I ran it for the Judge. I demonstrated addition, subtraction, and multiplication. All of these functions were performed correctly, thirty years after this model was built.

ASPRAY: After it was assembled? Was it still running?

MUMMA: I don't know. Veto any idea to try to make that thing run right now.

ASPRAY: What other work, if any, went on in this electronics laboratory before the war?

MUMMA: Well, I don't know. I don't have any good idea. I was so engrossed in my work I didn't pay a whole lot of attention. We were working on other more sophisticated types of counters. I know Mr. de Rosa was working on a ring counter. He called it the conjugate pair. I think he was trying to use ten high vacuum tubes instead of twenty to get a complete counting ring. In other words he was trying to share the operation of these tubes. He called them a conjugate pair. They worked on this sort of thing. This string of ten tubes was quite a good size. You saw that at the stockholder's meeting. As a matter of fact, at the stockholder's meeting they showed a tube that we did develop, a gas tube that was very small and had all ten sections in it. I don't know if you saw it sitting on top of the machine or not?

ASPRAY: Oh, yes I did see that.

MUMMA: We had one tube there that Mr. Desch developed; but we didn't get that operating real well. It operated well enough that we applied for a patent on it but it was never quite as fool-proof as the bigger unit. When the war was eminent, (we weren't in the war yet), we got in NDRC (National Defense Research) and we did work on communications. We could send information as a series of high speed pulses and pick them up and shoot them into a storage device. So that we could send maybe as high as twenty-five characters in one burst in a fraction of a second. You could send those characters out in this burst so quickly that anybody receiving it would just hear a click and that's all. We sent them out on a frequency of seven megahertz. That's forty meters wave length. And we had little receivers and transmitters set up. All you would hear in the receiver was just a click when the message was received; but there it was in the machine. You saw the numbers all set up.

ASPRAY: You say this was just prior to your getting involved in the war work?

MUMMA: Yes, we were doing this for the National Defense Research.

ASPRAY: Do you know what the intention of this was?

MUMMA: It was a secret communication system. Then we did another job for the military. We made a high speed counter for use in measuring muzzle velocity of cannon shells. We took it down to Aberdeen, Md. for testing. By using a combination of high vacuum and gas tubes we were able to generate and count one million pulses per second. We developed a gate that would start and stop the pulse generator accurately between pulses. This gate could be triggered on or off by the use of a single pulse. The pulse generator was crystal controlled to exactly one million pulses per second. To measure muzzle velocity, two inductive loops were arranged a known distance apart so that the cannon shell would pass through both of them. These loops generated pulses when the shell passed through to open and close the gate of the pulse generator. The pulse count for this interval gave the elapsed time in microseconds. Mr. J.R. Desch and I demonstrated this device to the people at the proving grounds at Aberdeen, Md. They were thrilled and wanted us to start manufacture right away. NCR had other obligations for the war effort at this time and could not take this project. So we gave it to another company to manufacture. I forget the name of the company that did make it.

ASPRAY: This was 1941 or 1942, something like that?

MUMMA: Yes. When was Pearl Harbor? Was that 1942?

ASPRAY: 1941.

MUMMA: Well, it was about that time.

ASPRAY: All right, you've mentioned war work. Can you tell me something about that.

MUMMA: Well, there is not too much I'm at liberty to say about it, except that we did work on a Navy contract. They moved us out of NCR building 10, into what is now building 26. At present it is the NCR computer sales

building on the corner of Stewart Street and Patterson Boulevard. While we were down there the Navy outlined to us what they wanted us to make and we made a device for them to help with the war work. It was a very hush-hush, secret device. We had marine guards around the buildings and about eight hundred Waves came in to help us produce this equipment. We also had many Navy technicians come in to help us.

ASPRAY: I have heard the name National Computing Machine Laboratory used. Is this a name associated with this?

MUMMA: Not really. After the war a group of people who worked with us on this project joined Bill Norris and went to St. Paul to organize the Engineering Research Associates for the purpose of continuing research in this same field for the Navy. Later this group became Control Data Corporation.

ASPRAY: That was after the war then?

MUMMA: Yes, after the war.

ASPRAY: I understand that Vince Gulden was also involved in this project?

MUMMA: Yes, during the war Vince Gulden was involved in this project at NCR.

ASPRAY: And Joe Desch was?

MUMMA: Joe Desch was in charge of this project at NCR. And Larry Killheffer was with us on this.

ASPRAY: Can you say whether it was electronic. I don't want to press you on anything you can't talk about, sir.

MUMMA: Yes, there was considerable electronics. The reason we were selected, I think, was because of our

expertise in electronic counting. In fact, a lot of IBM people worked with us down here. We had a lot of IBM people working as engineers with us. Of course, they went back to IBM after the war. We used counting rings and all kinds of electronic switching. We had electronic digital switching, which was new in those days. We also had some mechanical equipment to go with it. But all of the control circuits were electronic. It was a big mechanical job with the electronic control circuits. As a result we were able to operate it at speeds which were unheard of in those days.

ASPRAY: As I understand it this Navy group was moved wholesale, at the end of the war to Minneapolis/St. Paul area?

MUMMA: Yes. The people in the Navy went. Some of them must have gotten out of the Navy and they went back home. As far as I know none of the IBM people went up there. They went back to IBM. But for some of our engineers that we had hired...John Coombs went up there. He's the only one I remember out of our group that did go up there. They asked me over and over again, but I wouldn't go.

ASPRAY: Another name I've heard at this time. I'm not sure if he's associated is Arthur Kotz. Is that a name that's familiar to you?

MUMMA: It doesn't ring a bell with me.

ASPRAY: I know he was associated with the group when it went to St. Paul in 1946, but I didn't know if he was here before. Can you remember any of the people from IBM? The names of people?

MUMMA: I worked with two of them very closely. I don't know if they're still living now. I can't recall their names. [Since the interview I now recall one of the IBM engineers as Ralph Palmer.]

ASPRAY: Okay. This work that you did in the war -- did it provide valuable experience to NCR in terms of building products after the war?

MUMMA: I don't know; I don't think so really. It was so far afield from what we were going to do. It did give us an organization. But, you see, it was long after that before anything was produced at NCR. We did wind up the operation and go back up into NCR buildings and start up electronic research again. We went back and tried to develop new things. We worked on the magnetic data storage drums for instance. We worked on tape readers and tape handlers in those days. We began to work on printers -- high speed printers. We worked in this area after the war.

ASPRAY: This would have been what years, if you can be more specific?

MUMMA: Well, about 1945 or 1946.

ASPRAY: Am I correct in understanding that when the government eventually awarded several major contracts to ERA for magnetic drums, for example, I had understood I think that they were first offered to NCR, but that NCR turned them down.

TAPE 1/SIDE 2

MUMMA: Mr. Desch was under very great stress during this wartime operation and he had a nervous breakdown after the war. I took over his job as head of this electronic research after the war. So I was responsible for all these different operations that we were doing. I didn't say "yea" or "nay" about taking all these outside contracts although I probably would have said "no" because we were not in the position, ourselves to do it. We didn't take on a contract. We were more interested in getting something for ourselves. The management at NCR was not very happy about all this war work because it was taking so much of their effort. They wanted to get back into their cash register business, their accounting machine business, and that sort of thing. So they probably shied away pretty strongly from this ERA group and they didn't agree to any outside contracts.

ASPRAY: I understand that between 1942 and 1945 that NCR completely suspended any kind of commercial work and worked entirely on military work.

MUMMA: Yes. That's right.

ASPRAY: How did the company feel about continuing in electronics research as opposed to devoting all their money and attention to mechanical devices once the war was over?

MUMMA: Well, they didn't mind. This electronic research at that time was just a small operation. Of course we still had Kettering and Deeds around yet and they were still pushing for it. So, we probably weren't pressed as hard as we might have been pressed if they had really wanted to go into electronics. We were still considered outsiders in a mechanical factory.

ASPRAY: I see.

MUMMA: And we stood up for ourselves. It was quite a few years later before they picked up anything that they wanted to use. The first thing we did that they actually put in production was the punchtape unit attached to a cash register so data could be recorded on papertape. The daily transaction of the cash register were recorded and then run through a scanner to retrieve the information.

ASPRAY: When would this have been?

MUMMA: Well, it probably was 1948. Something like that. 1949. I'm not sure of those dates. I don't have a record of this information.

ASPRAY: Was there a real push by the administration to produce products at the time or were you just doing background research?

MUMMA: Mostly background research. There was no great push for products, although I had in my mind something I hoped they could use.

ASPRAY: What was this?

MUMMA: Well, several things. One thing that I could eventually use was this big counter. We had this multiplier. We took the whole multiplying section out and improved it with 5696 xenon gas tubes, which was a better tube than we had used before, and put it in production as the Class 441 multiplication attachment for one of the NCR accounting machines. So the machine as it went through its cycle would make automatic extensions from billing operations. It would make the multiplications automatically.

ASPRAY: I see. When would this have been?

MUMMA: I don't know. I had a figure at one time of how many we made. We made quite a few of those machines and we sold them with our Class 390 accounting machines. I don't know what year it was. It was considerably after the war. It was in the 1950s sometime.

ASPRAY: The 390 machine was introduced in 1960.

MUMMA: 1960. That late. Okay.

ASPRAY: What other products came out of the work you were doing in your lab?

MUMMA: Well, we made a high speed printer. The drum printer. We produced that.

ASPRAY: Can you tell me a bit about that printer? How it was designed? How it compared with competition at the time?

MUMMA: Well, it was fair. It was a large continuously rotating drum with rows and rows of characters engraved on the surface of the drum. It had a row of hammers, one for each character position on the printed document, that would fire the instant the selected character appeared in front of the hammer. the hammer had to come up and drop back and drop very quickly. This was necessary to prevent smudging. The printing rate was limited by the time the hammer was in contact with the inked ribbon and the document over the selected character on the drum.

ASPRAY: Was this the same technique that other companies were using for their printers?

MUMMA: Yes. Pretty much the same technique, except that we tried to make the characters on the drum stop momentarily while the hammer made contact with them. The shaft and drum were designed to resonate at the proper frequency to cause each character to stop momentarily in its rotation during the impact of the hammer. A magnetic device was developed to excite and synchronize the rotational oscillation of the drum with each character position. Shaft fatigue and the resultant fracture of the shaft caused us to abandon this approach. Prior to this project to improve the state of the art for drum printers, we had switched from Research to Development Engineering for Production. We developed high speed printers, magnetic tape recorders, paper tape readers and punches, and high speed check sorters for banks. Pitney Bowes cooperated with NCR in the development of high speed check sorters.

ASPRAY: Right. This was in the 1960s though.

MUMMA: Yes that was all later. In my earlier days at NCR I did make one thing. I made type wheels for one of our cash registers that would print little bars on the tape which could be read as a bar code on the proper equipment. I didn't have an optical character recognition device at that time but you could read the bar code easily. So you could read the information off the printed tape instead of having to punch holes in the tape. I don't remember any patent being issued on that. Also, I totally forgot that I did develop a special transfer sheet similar to carbon paper except that iron oxide was substituted for carbon. It is still used to print the amount on bank checks during the proof operation. That was patented in 1956.

ASPRAY: How was that used?

MUMMA: At this time Banks were starting to print the Bank Number, Check Number, and Account Number in Magnetic Ink along the bottom of the checks. This information was preprinted at the same time that the check was printed. However to more completely automate bank check handling it was necessary to print the amount for which the check was written in magnetic ink. This was done when the checks were proven against the deposit slips when they were returned to a Bank for deposit. This iron oxide coated paper was used as a ribbon in the machines that printed the amount in magnetic characters during the proving operation. NCR licensed the manufacture of this iron oxide ribbon as long as my patent #2,744,031 was valid.

ASPRAY: Why don't we change subjects for a short time and come back to this. In 1953 NCR acquired CRC. Can you tell me something about the background to that? For example, what was the company's strategy in acquiring CRC?

MUMMA: Well, at that time they felt that they wanted to get into electronic computers and that sort of thing. By that time the big general purpose computers were getting more play. Prior to that we had been down to see the Univac. Eckert and Mauchly had a company of their own before they were picked up by Sperry.

ASPRAY: In Philadelphia.

MUMMA: Yes. We went down there with the intent of purchasing that company. We looked it over but I don't know if they couldn't get it together over price or what. Sperry Rand came in and purchased them and we didn't. So we were still looking around for some way to get into the computer business. Because we didn't have anything in the wings that would take the place of these big computers. All we had were small, special purpose machines.

ASPRAY: You didn't feel like you could move into the big ones from your project?

MUMMA: No. We didn't have the staff to do it. And like I say, NCR was not interested at that time in building up the staff. At any rate, it was a lot easier and quicker to go out and buy a company. Computer Research Corp. in California approached NCR for help in getting into business computers. We went out to see them. But in the end, we purchased the company, but went to General Electric to build our first computer. Computer research furnished the staff to work with General Electric in the development of the first NCR computer. Our Class 304 computer.

ASPRAY: So as far as you know NCR had always planned to market the machines that CRC built after they acquired them?

MUMMA: Well, that's probably what they had in mind at that time. But there wasn't enough market for then. At least it seems that not many that I know of were sold. They were scientific computers, not business oriented. I didn't know much about the activity in selling machines until the NCR 304 came out. Carl Rench probably knows more about that than I do.

ASPRAY: I know that CRC built a machine called the 102D in 1953. And NCR was considering marketing it and then they pulled back from doing so.

MUMMA: Yes. That's right.

ASPRAY: Why did the company feel that they wanted to get into these large machines? Did they feel that there were really commercial uses for them at the time?

MUMMA: They undoubtedly did. In fact, they felt they would be left at the post if they didn't. They just had to get into that field. NCR dominated the point-of-sale market and they didn't want to lose that point-of-sale operation. And they knew they had to tie these into some sort of a computer. I think that was a main reason.

ASPRAY: Now it was recognized at the time that CRC was a company building military and scientific machines, not

commercial machines.

MUMMA: That's right. That's probably why they couldn't sell but one or two.

ASPRAY: What were thought to be the differences between a commercial machine and a scientific machine at the time?

MUMMA: A scientific machine has to handle various types of operations and doesn't have to handle just great reams of repetitive data that a commercial machine has to handle.

ASPRAY: So one of the problems that the CRC people may never have faced was one of input and output devices?

MUMMA: That's right. To tie into them.

ASPRAY: So a lot of the research that went on at NCR was along these lines?

MUMMA: Well, along the line of input/output devices.

ASPRAY: Right. Especially using their traditional equipment?

MUMMA: That's right. To make their equipment become a terminal. That's the idea.

ASPRAY: You were involved in a lot of that work?

MUMMA: Oh yes. In fact, from the war on I was involved in that pretty much. Mr. Desch didn't come back into the operation until about 1952 or 1953 sometime after that. After Mr. Desch came back to active duty. I continued on as Manager of Peripheral Equipment Engineering.

ASPRAY: What kinds of problems did you have in taking the traditional mechanical devices that NCR had marketed as point-of-sale equipment and facilitating their use in electronic systems?

MUMMA: We really didn't do too much with those devices outside of putting readouts on them to operate paper tape punches. They were never completely redone until Mr. Anderson came in. That's when he blew the place apart. Until he came in they just couldn't divorce themselves from mechanical machines. We could put readout devices on them but we still had the basic mechanical machine.

ASPRAY: When you put the readouts on them was there still some necessity for human intervention? Or could they function as a system without somebody reading out material and then entering it into a different machine?

MUMMA: The only human intervention was taking the tapes off of the machines in the evening and running them through a tape reader for the computer. The tape would just go on and be recording the data while the cash register was recording sales and the clerk didn't pay any attention to it. We had a lot of those installed over the country. That's one way to collect data from cash registers. We also made a machine for the banks called the Post-Tronic in which we could pick up the old balance from magnetic stripes on the back of the ledger card. After the new entries were posted, the new balance was recorded on the same magnetic stripes on the back of the card. This became the old balance the next time the card was used. We also we had a magnetic stripe on the 390 on which we stored information.

ASPRAY: Could you tell me something about the company's interest in and participation in MICR? How did this project come about and what products came out of it?

MUMMA: In the early 1950s Stanford Research, a Division of Stanford University at Palo Alto, Ca., approached NCR with a device capable of reading 14 different characters printed with magnetic ink. This device was an Analogue Reader that recognized the wave shapes generated as a single gap magnetic reading head passed over previously magnetized printed characters. These characters represented the 10 numeric digits and 4 symbols identifying the

numbers with which they were associated. The 10 numeric characters could easily be read visually as numeric digits by the average person. A manufacturer's Group was organized in the early 1950s to standardize the shape and size of these 14 characters along with the ink to be used for printing.

The following companies were represented on this committee: NCR, IBM, Burroughs, Addressograph-Multigraph, Pitney-Bowes, Standard Register, Univac, and Delux Printers. Later, after these characters were standardized for readability, the Federal Reserve Bank and the American Bankers Association people were brought in to obtain their acceptance. These characters were accepted by the Bank's representatives in 1956. In 1959 a booklet was published by the American Bankers Association describing these magnetic characters and their use in detail. This booklet is identified as Bank Management Publication #147. A Third Revision of this booklet #147-R3 was published in 1967.

ASPRAY: Could you read me the titles and citations on these so I have it on tape for those two books that you have in front of you?

MUMMA: One book here is *Common Machine Language For Mechanized Check Handling, Final Specifications and Guide to Implement the Program* published by the Bank Management Commission, American Banking Association. This was dated April, 1959. That book was No. 147, by the way. Then they put out a supplement to that 147R3, *Automation of Bank Operating Procedures, Common Machine Language For Recognized Check Handling, Final Specifications and Guides To Implement the Program*, Department of Automation, American Banking Association. These books described the printing and gave detailed layouts of the print; so that you get exact measurement of the magnetic printing for each one of the characters. There were had the ten characters 0-9. There was a "transit number" symbol. Then there was an "amount" symbol. Then there was another character called the "on-us" symbol which indicates the bank number. Then there was a symbol for a dash. So these symbols would precede a number and identify whether it was the amount, whether it was your account number, or whether it was the bank number. There are four symbols plus the ten digits. We worked it out so these characters could be read on this machine that Stanford Research just developed and also on the IBM multiple head magnetic character reader.

ASPRAY: NCR marketed equipment, then, in this field?

MUMMA: Yes. NCR built the check handler with Pitney-Bowes. Pitney-Bowes supplied the mechanism for the check handler and NCR supplied the reading equipment. NCR put them together and NCR sold it as a product. Bank America was our first customer.

ASPRAY: Quite successful, I believe.

MUMMA: Well, yes, although eventually IBM proved to have the best check sorter. There were always problems in handling paper because checks you know are carried in peoples' pockets and were not perfectly flat. We had trouble feeding doubles. That's the problem you have, of not separating checks apart so you can read each one. And if you have a double, of course, you miss one of the checks. That machine worked very well but not quite to our satisfaction so then NCR bought the design of a machine, from Univac at that time. They had developed the machine but decided not to put it in production. It didn't work much better than our own design. I don't think either one of them are used today. NCR now purchases a check sorter designed similarly to the IBM check sorter.

ASPRAY: If you don't mind, I would like to ask you questions that go over a wide range of things. They're sort of questions that Mr. Rench suggested that you could answer better than he could or things that I didn't get around to asking him yesterday. So there is no continuity in these questions. One of the things that I wanted to explore was the relationship between the research facilities in Dayton and the research facilities in Hawthorne, California where CRC was located. I guess it became a division of the company later?

MUMMA: Yes, it did.

ASPRAY: What were the differences between the two? What did each of the groups work on?

MUMMA: CRC became a division of NCR and worked on the mainframe mostly. They also developed magnetic disk memories and magnetic card memories. I'm trying to think of the name that applies to it now.

ASPRAY: CRAM.

MUMMA: That's right. Card Random Access. Those were the devices they worked on and we worked on the rest of peripherals, printers, magnetic tape handlers and papertape punches, readers, and this sort of thing.

ASPRAY: Was that decision made because there was already certain expertise in the mechanical area and the peripherals seemed to have more relation with that?

MUMMA: I think it was based on expertise, yes. We had more expertise on the electro-mechanical devices.

ASPRAY: Were there any problems by having the two groups separated from one another?

MUMMA: Only the normal communication problems. We traveled back and forth and kept in contact. Our equipment could always talk to their equipment. I mean we had to get together to be sure that our equipment would work with theirs. We had not problems really.

ASPRAY: How were research funds allocated between the two groups? Can you say something about that?

MUMMA: Each group would put in their request for a budget for the year. I guess they got what they needed. Our budgets were generally approved.

ASPRAY: There was no feeling there of competition for funds?

MUMMA: Oh, sometimes. There was more competition for projects. There got to be a time when NCR would have both of us compete on the same thing and pick the one that worked out the best.

ASPRAY: When was that strategy taken?

MUMMA: Well, it was later when Robert Chollar was Director of Corporate Engineering. I don't know if you're familiar with him or not?

ASPRAY: No, I'm not.

MUMMA: He was Director of Corporate Engineering, following Charles Kennoy. I don't know if you know these names or not.

ASPRAY: No. Why don't you tell me a bit about these people who were in charge of engineering.

MUMMA: I'm trying to think who was the head of it. The first Director of Corporate Engineering at NCR was Mr. Harry Williams. He was followed by Mr. Charles Kennoy. He was brought in from the sales department because of his interest in Electronic Business Machines. So Mr. Allen brought him in as Director of Corporate Engineering, including the group in Hawthorne, California.

ASPRAY: This would be what year? Can you remember?

MUMMA: Years always get me. I'd just be guessing.

ASPRAY: But it is during Mr. Allen's term?

MUMMA: Oh yes, during Mr. Allen's term of office. It might have been back in the early 1950s, I'm sure it was. Mr. Kennoy was Director of Engineering for a good many years. I don't know if he spent too much money or what. But he fell out of favor with Mr. Allen and Mr. Chollar took his place.

ASPRAY: Mr. Chollar's first name?

MUMMA: Mr. Robert Chollar. He tried to use this idea that competition was good and had us bid for jobs. It never worked out too well. We did a more cooperative job under Mr. Charles Kennoy than under Mr. Robert Chollar.

ASPRAY: Can you give me a rough idea when Mr. Chollar came in?

MUMMA: Well, Mr. Allen was still there yet. If it was as late as the 1960s or not, I don't know. It would be late 1950s or early 1960s when he came in.

ASPRAY: Okay. Good enough. Were these positions staff or line positions?

MUMMA: These were line positions.

ASPRAY: Okay. This is really outside of your area but since you were in the company I'll ask anyway. I'm just trying to get some feeling for the structure of the organization in the late fifties. Can you help me with that? For example, can you tell me how work on mechanical versus electronic projects came about? Were there separate manufacturing arms for mechanical and electronic devices?

MUMMA: No. I don't quite know what you mean by that. The electronic and electro-mechanical equipment was made in a different part of the factory from the mechanical accounting machines and cash registers. They were both under the same corporate management however.

ASPRAY: Did all of the manufacturing go on in Dayton?

MUMMA: The only manufacturing of our equipment went on in Dayton. The equipment that they developed in Hawthorne was manufactured in Hawthorne.

ASPRAY: Was manufactured in Hawthorne?

MUMMA: That's right. We never did manufacture anything that was developed in Hawthorne in Dayton. They were two separate operations. They had their own manufacturing out there and we had our own manufacturing here. So we manufactured peripherals here basically. They manufactured mainframes, plus disks and CRAMS out there.

ASPRAY: What about sales and marketing of the products? Did the same sales force market the electronic devices as marketed the mechanical devices?

MUMMA: No, I think they used specialists. The Bank Division was the first sales division to sell electronic electro-mechanical products.

ASPRAY: They did use specialists?

MUMMA: Yes. A separate sales division was set up to sell computers and computer systems.

ASPRAY: I know that NCR had always had a very strong marketing network for its mechanical devices spread throughout the country.

MUMMA: That's right.

ASPRAY: Were computer sales made out of Dayton or were they out of regional centers?

MUMMA: Well, at first they were sold out of Dayton. But then they went to the regional centers, finally, when they got enough men trained that they could handle the regional centers. The biggest problem was training servicemen. They had a horrendous job training servicemen. I tried to get them to bring in college electrical engineering

graduates for servicemen. They were interested in people with electronic technician training. They did finally get enough servicemen trained. In the meantime, we sent engineers out into the field to help in the more serious cases of trouble. This gave our engineers an idea of the need to design more reliable equipment.

ASPRAY: Was that fairly typical that people would be called out of the research and development labs to go out to check on problems, especially at the beginning of a product run?

MUMMA: Yes, that's right. That's what happened. They called you on the phone and asked you questions and if it was serious enough we would go out to placate the customer and hopefully solve the problem.

ASPRAY: Was there a feeling in the company, especially in the late 1950s, early 1960s of a real competition between the mechanical and the electronic devices? The reason I ask this question is that when I was reading all the annual reports for the late 1950s and early 1960s, they give sort of major play to their new electronic devices but then there are very strongly worded comments that there's always going to be room for mechanical devices, and so on. Can you talk to that?

TAPE 2/SIDE 1

MUMMA: Yes. I think we were a little bit ostracized. We worked with a group that was strongly mechanical and they felt a little fear of encroachment from the electronic group. So we were kind of pushed off to the side a little bit. The company never did go into electronics with all four feet until Mr. Anderson came. They just always hung on to the mechanical machines. But I think by the time he came they saw the handwriting on the wall. You see our cash registers were getting quite expensive. We were facing more competition all the time from these electronic devices and it made it hard to sell against that. In the mechanical business we didn't have the competition because it took so much tooling to get started in this mechanical work that we could charge almost anything we wanted to. So the company maintained the same wage structure as General Motors. They were paying good high wages to people for this mechanical work. They could always charge more for the cash registers and the accounting machines because

nobody could compete with them. But when the competition started up in electronics then that began to change and the raises were not forthcoming. So then the UAW came in and said they'd straighten it out, they'd get the money. When the workers voted for UAW representation and the company did not meet their demands, they called a strike. That's when the company decentralized and spread out all over the country. This broke up the strike. About that time Mr. Anderson came in. Now instead of paying maybe $10 or $12 an hour for this work, this highly skilled mechanical assembly work, they are down around $5 or $6/hour for relatively unskilled labor. This was very hard to take for these people at first.

ASPRAY: Now the labor union that came in was the steel workers, not the autoworkers that represented the NCR employees?

MUMMA: UAW.

ASPRAY: It was UAW?

MUMMA: Yes. Autoworkers. This was confirmed by Mr. Lyle Shafer, Vice President, Personnel Resources.

ASPRAY: Because Mr. Rench told me the steel workers, yesterday.

MUMMA: Oh I'm sure it was the autoworkers.

ASPRAY: O.K. that's fine.

MUMMA: I'm almost sure because no steel workers were involved. He must have just forgotten that for a minute.

ASPRAY: If one had ambitions to move up in management in the company, was it a bad idea in the 1950s to be in the electronic side?

MUMMA: As long as I was with the company the electronic field didn't move up very far in management, that's for sure. But that's understandable. You had to understand what the company was like at that time.

ASPRAY: Does that mean that the administration, especially the people who had moved up from the mechanical side were more conservative and less understanding of the electronic side?

MUMMA: Yes. They didn't have an understanding of what was going on in the electronic equipment field. This was the problem. Now the management today is a lot different. People that you talk to now in management are electronic people. They know what's going on.

ASPRAY: Could you tell me about the way you "programmed" this four arithmetic operation machine, your second calculator?

MUMMA: First, I should tell you that multiplication is performed by high speed repetitive addition of the multiplicand. The number of additions is determined by the number in each denominational order of the multiplier. Addition is accomplished by transmitting electrical pulses from a controlled electronic pulse generator through an electronic denominational order switching device into a multidenomination accumulator or adder. Each pulse will advance a selected denominational order counting ring in the adder one position. Each denominational order of the adder consists of a ten position electronic counting ring. Every time the "zero" position is caused to conduct and the "nine" position extinguished, a transfer pulse is automatically transmitted to the next higher denominational order of the adder.

This device has four pulse generators, each capable of transmitting a maximum of nine pulses. There is one pulse generator for each denominational order in a four digit multiplicand. This device also has a four denominational order multiplicand keyboard with nine keys in each order. No key depressed indicates a "zero". Similarly this device has a four denominational order multiplier keyboard with nine keys in each order. In order to multiply, the multiplicand

and multiplier are set up on their respective keyboards. The "multiply" function key is depressed. Multiplication is initiated by depressing the "motor bar" or "start button". You will notice that the multiplicand and the multiplier keyboards serve as the memory for the multiplicand and multiplier. These keys are released when the multiplication is complete.

I should point out that the number of pulses generated by the multiplicand pulse generators is controlled by the digit key depressed in each order. If no key is depressed in a particular denominational order, that pulse generator is bypassed and a "zero" is indicated.

The pulses from the highest denominational order of the multiplicand are delivered to the product adder first. The pulses from the lower denominational orders of the multiplicand are delivered in sequence in descending order. This is done so that the transfer pulses in the product adder will not interfere with the incoming counted input pulses from the pulse generators.

The multiplier keys control the number of times that the four orders of multiplicand pulse generators operate. In this case the 1000s order of the multiplier keyboard switches the output of the multiplicand pulse generators so that the pulses enter the "1000," "10,000," "100,000," and "1,000,000" order of the adder respectively. Multiplication is started with the highest order in the multiplier keyboard and continues in sequence down to the lowest order. With no key depressed in a denominational order of the multiplier keyboard that order is skipped and the multiplicand pulse generators drop down to the next lower order. In the case of the units order multiplication is terminated. This electronic switching is controlled by an electronic program counter that follows the multiplying operation through to completion releasing the multiplier and multiplicand keys. The product in the adder is displayed on an electro-mechanical indicator mounted above the key board. The displaying of the product takes longer than the actual multiplication. The pulses in this machine are generated at the rate of 10,000 pulses per second. When multiplying 9999 by 9999 a maximum of 1500 pulse times are used to calculate a product. The elapsed time is 0.15 seconds.

Using this type of programming, addition is accomplished by multiplying by one. The higher denominational orders in the multiplier are skipped with no loss of time. Depressing the "add" key sets up this program. Additional numbers may be set up on the multiplicand or add keyboard and entered into what is now the "sum" adder. In this model an extra two denominational orders of keys were added to the add keyboard by the depression of the "add" key.

The "subtract" key operates in the same manner as the "add" key except that the direction of the counting rings in the adder are reversed. The transfer pulse is now generated when the "zero" representing the tube is extinguished and the "nine" tube conducts. This reversal of the electronic counting rings is accomplished with electro-mechanical relays.

There was no provision in this machine to program repetitive calculations. No internal memory was provided to take the place of the keys on the keyboard. This machine was made to demonstrate one way of adding, subtracting, and multiplying using electronic computers.

ASPRAY: So if you wanted to carry out a computation that required a whole sequence of operations you'd have to do those manually.

MUMMA: Yes, that's right. If you wanted to make this multiplication, you'd have to make your entries on the keyboard and hit the multiply key again. You could leave the total in the product adder and add to or subtract from it. Also, you could add products from repeated manual multiplications.

ASPRAY: Was there any kind of storage for the machine?

MUMMA: The only electronic storage was in the accumulator or adder. It has an eight denominational order adder. As mentioned before the keyboard acts as a manually operated storage.

ASPRAY: Did people actually use this machine to do some computations?

MUMMA: No, this machine was only used to demonstrate the principle of electronic calculation. However, this same multiplier was used with 5696 thyratrons in the Class 441 multiplier attachment for the Class 390 Bookkeeping Machine. This machine was sold by NCR for several years before it was replaced by more sophisticated equipment.

ASPRAY: Can you tell me anything about other people that were major people in R&D in the late 1950s? People that you have not mentioned to me yet. Some new people that came on.

MUMMA: In our group?

ASPRAY: Yes, in your group.

MUMMA: Of course Carl Rench came to us at the end of the war. You just met with him. I think he served in the Navy.

ASPRAY: That's right.

MUMMA: Carl Rench headed a group at that time working with Product Planning and Sales to develop an electronic computing system for NCR based on our knowledge of the state of the art at that time. James Taylor, Frank Laub, and Virgil Reese came next. First they developed a paper tape punch attachment for cash registers. These were used to automatically collect data at the point of sale. Later, Peripheral Equipment Engineering was established under my direction. At that time, James Taylor was placed in charge of high speed printers. Frank Laub was placed in charge of a section responsible for establishing the quality of the electronic components used in our development. Virgil Reese was placed in charge of magnetic tape handlers. Later William Koverman was placed in charge of high speed paper tape punches. Ervin Doberstein was placed in charge of high speed card punches. Louis Sandor was placed in charge of high speed bank check sorters which read magnetic characters printed on the checks.

By the time I retired in 1969, NCR was purchasing most of their peripherals from outside sources and Peripheral Equipment Engineering ceased to exist.

ASPRAY: I see. Can you remember the names of some of the people that were in Hawthorne?

MUMMA: No, I don't. I was not so intimately involved with them. I do remember Al Doig because I have kept in touch with him through the years. At the moment I can not even remember the man in charge of the Hawthorne operation.

ASPRAY: Eckdahl.

MUMMA: Eckdahl. Yes, Don Eckdahl. I knew him quite well but have lost contact in recent years. Another name comes to mind. It is Sarkissian. He was a contact man between NCR Dayton and NCR Hawthorne. Frank Laub eventually moved out the new NCR plant at Rancho Bernardo, Ca.

ASPRAY: Okay, fine. Thank you.

END OF INTERVIEW