

An Interview with
ISAAC L. AUERBACH

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Conducted by Nancy Stern

on

10 April 1978

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

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Isaac L. Auerbach Interview
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Abstract

Auerbach recounts his experiences at Electronic Control Company (later the Eckert-Mauchly Computer Company) in the period 1947-1949. He emphasizes the economic and practical infeasibility of the BINAC computer project for Northrop Aircraft. Auerbach also discusses the UNIVAC, including personalities, politics, and its technical features. The roles of the National Bureau of Standards, Northrop Aircraft, Raytheon, Remington Rand, and IBM are brought into a perspective relative to the development of the UNIVAC.

ISAAC L. AUERBACH INTERVIEW

DATE: 10 April 1978

INTERVIEWER: Nancy Stern

STERN: Mr. Auerbach, when did you start working with Eckert and Mauchly?

AUERBACH: Either April or May, 1947.

STERN: How many people were employed at that time?

AUERBACH: I was the 7th employee to join the company. The company was then called Electronic Control Company.

STERN: And your job involved what?

AUERBACH: I was initially assigned to work with Brad Sheppard in the development of the mercury memory; specifically I did the electronic circuitry and Brad did the mercury tank.

STERN: Had you had any experience with computers prior to that?

AUERBACH: No formal experience, although I had worked with digital circuitry during the war, in the development of the Mark IFF system.

STERN: I see. So essentially it was an engineering task, to begin with?

AUERBACH: Yes.

STERN: Were you involved specifically with any of the initial UNIVAC contracts in that period?

AUERBACH: There were no UNIVAC contracts then. When I joined them, I was the first non-ENIAC employee to join the group. When I joined them, we had two contracts. One was...well, there were maybe three. One was the development of a memory system for the National Bureau of Standards.

STERN: That was a study contract, at that point.

AUERBACH: A small study contract, yes. The second was the development of a magnetic plated tape for the tape drive and the third, which I think followed later, was the development of an arithmetic unit. All study contracts. Two, if I recall, were with the Bureau of Standards, and the third was with Prudential Life Insurance Company.

STERN: I see. Was the second contract a confidential one? A Secret classification? To your knowledge?

AUERBACH: There were no classified contracts whatsoever in the company when I joined it, or during the entire tenure of my stay at the company. The company did not have security clearance. This work eventually led to the development of the BINAC computer.

STERN: But this was a contract with NBS, whereas the BINAC was with Northrop Aircraft.

AUERBACH: That's correct.

STERN: The first two contracts you were referring to: was that the \$75,000 deal with NBS for the Census Bureau...peripheral tape unit? And Prudential was also a study contract, at that point?

AUERBACH: Correct.

STERN: Can you tell me a little bit about the security problem that Eckert and Mauchly faced?

(Tape turned off here.)

STERN: My question is whether the BINAC was an operational computer?

AUERBACH: Not in the sense that it ever did any application-oriented work. That it ran demonstrations--yes. But it never produced final work. Either at Eckert Mauchly, or, to the best of my knowledge, at Northrop. At Northrop it was basically a model, but it never did the job for which it was originally designed, which was star tracking.

STERN: Why?

AUERBACH: You have to understand the drive behind the machine and the drive behind Eckert in designing the machine. When we built the first memory, it was a 5 megacycle pulse rate system. And using vacuum tubes we were pressing the state of the art to the very limit of our ability to get both tubes and resistors, and condensers, and inductors, and circuit boards and everything else to produce pulses with sharp rise and fall times. It was just on the hairy edge of the state of the art. The Techtronic scopes which were the best available at the time would just about let us see what was going on. And so everything was just on the hairy edge.

When the decision was to proceed to design the BINAC, Eckert lowered the clock frequency to a 4 megacycle pulse rate. I, among others, pleaded with him to make it lower--go down to 2 megacycles. Before I left the company, and we were running out of money, I said that what I really wanted to do was to take the BINAC design and build a 1 megacycle version of this machine and put them out on the commercial marketplace. Eckert categorically refused.

STERN: Why did he categorically refuse?

AUERBACH: Well, Eckert was always a believer that if you press the state of the art, you can eventually make it

work. He felt by backing down 20%, that was enough margin, and since we built the demonstration model of the mercury memory at 5 megacycles, we're sure to make it work at 4 megacycles. We had great difficulty in the length of the wire and its closeness to other wires and the chassis, that is the capacitance in the circuits that decreased the rise and fall times of pulses that were associated with the machine at the time. I built a number of subsequent computers immediately thereafter, at lower frequencies, and handled these problems very differently and I had no difficulty making these machines run in 2 megacycles. None at all.

STERN: Would you say the, in 1948-49, you pushed the state of the art too far?

AUERBACH: Yes.

STERN: And that was the reason the BINAC was not operational?

AUERBACH: Yes.

STERN: What about the controversy over whether BINAC was to be an airborne computer?

AUERBACH: I was right in the middle of that one. The original contract was to design this computer to be airborne, which I didn't find out until well into the contract. And when I was told that, I said, "You people are out of your minds. You're not going to build this BINAC computer to fly! I tried that during the war and we had one helluva time building IFF equipment that we could make fly. And we just have no competence here to do that."

Well, we had to make it fit through bomb bay doors of--I forget the airplane that it was supposed to go into. But that limited the physical size of the computer since it had to get through the bomb bay doors. We then suddenly were faced with designing the frames in aluminum rather than in steel to reduce the weight. There were just a lot of what I personally considered--and even more strongly consider now--to be extremely bad engineering to consider building a computer of that kind under those primitive conditions, that would fly. In my considered judgment, that BINAC

would never have operated in a vibrating airborne airplane. No possibility.

STERN: I'm a little confused on some of this business over the airborne nature of the computer. There's nothing in the Eckert-Mauchly documents, or the interoffice memos of which there are a considerable number, that says anything about directing engineering attention to this particular problem. Which has led me to think that maybe they didn't consider it part of their responsibility to do this.

AUERBACH: Well, then, you know the specifications to which the machine was designed.

STERN: I've seen the contract. Now, the contract says the ultimate purpose of this computer is to be airborne. But, based on Baker's memorandum back to Northrop--to Rawlins and Bell--he talks about the fact that "once we get it back to California, we'll make it airborne." It's not clear to me whether that was the original intent or that they were just dissatisfied with the progress and felt they ought to do it that way.

AUERBACH: I really couldn't tell you what was in Baker's mind, whom I knew very well. I know that when we found out about it--oh, when I was in fact designing the mechanical structure for the power supply, and was suddenly told that we had to build this of very light weight. The design came down to me with aluminum channels, and I said, "The design will not support the transformers; they will bend the struts." And we had a very difficult argument on the issue. I think we built one frame of thin aluminum and it bent the struts, at which point I was allowed to then go out and buy aluminum that we would have less difficulty with. That's when we knew that we had to build this thing for airborne purposes and it had to fit through bomb bay doors.

Specifically, with regard to memoranda, we did not communicate very effectively by memoranda at Eckert-Mauchly. Eckert communicated by telling people what it was they were to do. And he came around every day and told you what it was that was supposed to be going on. Very, very little documentation.

STERN: Well, Mauchly was responsible for getting the business, I assume. At least, that was part of his role, as

President. Is that a fair estimate, would you say?

AUERBACH: Mauchly had a much bigger reputation, was the older and more senior individual who understood application problems in much greater detail. Eckert was an extraordinarily bright engineer and was primarily concerned with the engineering aspect of things. When it came to the business end, neither man was particularly competent in business. The day that the National Bureau of Standards was to come up to negotiate the contract, that morning at about 8:30, Mauchly walked into my office, handed me a copy of this proposal or whatever it was at that time, and said would I come in and help negotiate this contract. I had never read it at that point. And so that's how I got very, very involved with the negotiations for the first contract with the National Bureau of Standards for UNIVAC. And later with the Signal Corps for UNIVAC.

So the answer to your question as to whether Mauchly was responsible for getting the business for the company--I would say he had conversations that led to the subject, but neither of them were business-oriented.

STERN: Well, to get back to the BINAC: what confuses me is Eckert--everyone talks about his phenomenal engineering abilities--should he have been aware of the fact that it would have been too difficult to build this at that period of time? Or were they just simply looking for any kind of contract that they could get to sustain themselves?

AUERBACH: Eckert was one of the most creative computer engineers and circuit designers at that time. This did not make him a practical engineer, or a person who faced the realities of designing something that would work, or that you could manufacture. He was just an extraordinarily creative and ingenious man.

STERN: Well, that sounds like the Babbage syndrome, if you don't mind my saying so.

AUERBACH: Yes. Yes. The only way they ever got machines done after I left was to literally put walls around the place and Eckert was forbidden to come in.

STERN: Because there was a constant--

AUERBACH: Every time you would design something, he had a change--he had a better way of doing something, and you never could finish the design before he had a different design; and then that one had to be rebuilt and checked and made to work and the tolerances worked out. I mean, it was every day with something new. I sometimes had the thought that what Eckert was trying to do was to effectively invent everything that had to do with computers and go down in history as a brilliant inventor. I mean, he documented everything for patent purposes, but not for practicality and work purposes--no. I did not learn how to build practical computers at Eckert and Mauchly. I learned about the computer business at Eckert and Mauchly.

STERN: Okay--just to finish up on this BINAC thing--Northrop accepted the BINAC. They had it--it was built for an original purpose, working with this navigational device--as a kind of automatic pilot, as I understand it. If it was clear to Northrop before August of '49 that this machine would not do what it was supposed to, why would they accept it?

AUERBACH: I really don't know why Northrop would accept it. I could only judge why I thought they would have accepted it. But I don't know why they accepted it. In my opinion they could have accepted it because they didn't think that any more was going to be accomplished; that the machine would not be finished any more than it was, and that the exercise to learn how to design and build a computer had been fulfilled, and nothing more was going to be accomplished.

STERN: You say "the exercise to learn to build machines had been fulfilled." Was that desire implicit in the contract?

AUERBACH: Never explicitly stated.

STERN: But implicitly you would say it was there.

AUERBACH: Knowing the men who were involved in the design of MADDIDA--yes.

STERN: Well, those men have been interviewed by the Smithsonian and have claimed they were very upset about the fact that Northrop went to Eckert and Mauchly; that they felt even in '48 that they could build their own computer.

AUERBACH: That's correct.

STERN: But the powers-that-be at Northrop felt that they needed to go outside for--

AUERBACH: Yes, ma'am. Northrop could go down in history as having been in the very earliest stages of computer development in the United States and walked away from it.

STERN: By not allowing their own engineers to--

AUERBACH: By not following through. By not knowing what they had in the way of talented engineers, or the work that was being done within their own office; not just in connection with MADDIDA and BINAC, but with regard to the design of a number of IBM computers that IBM put in production that were designed at Northrop.

STERN: I see. I wasn't aware of that. Okay. But I am correct in deciphering or reading between the lines in the correspondences between Baker and Bell that Baker was aware of the fact that Eckert and Mauchly were not proceeding according to the requirements of the contract.

AUERBACH: I would say yes.

STERN: Okay, because there again it's implicit; it's not explicit--

AUERBACH: I wouldn't say that, but I've heard Baker say that, yes.

STERN: Okay--back to the National Bureau of Standards contract: it seems to me that NBS's involvement with computers from '46 on was very much because they were interested in becoming important protagonists in the state of the art. The Bureau themselves, that is. Would you say that's a fair assessment?

AUERBACH: Well, initially you'd have to say that there were two things involved: 1) that Curtiss and others were very anxious to develop a machine that was more effective in processing census data. And Census funded the National Bureau of Standards to both acquire a UNIVAC as well as to develop computers. I would then say that Alexander and Curtiss became the protagonists to jump into the computer race in the sense of trying to establish some eminence for the National Bureau of Standards in this field--yes.

STERN: Okay--now.

AUERBACH: Certainly, Alexander was oriented in this direction.

STERN: How about Curtiss?

AUERBACH: Yes.

STERN: The contract that Raytheon signed with ONR (Office of Naval Research) was a cost-plus fixed fee contract, as I understand it. The contract that Eckert and Mauchly signed with the National Bureau of Standards was for a fixed amount. Why didn't they negotiate for a cost-plus?

AUERBACH: I stated that in my opinion neither Eckert nor Mauchly were competent businessmen. I had been brought in to try to negotiate the UNIVAC contract, and one of the questions was its price. Eckert gave me his costs which were \$80,000 to build a computer. A UNIVAC--UNIVAC I. And I came back and said "there's no possibility of our doing it for that price." Just taking the bill of materials that Eckert gave me, and knowing what little I did at that

time, I was to come up with the cost of the UNIVAC in two days. I had a number that was like \$180,000 or \$190,000. Eckert said categorically I didn't know what the hell I was talking about, I didn't know anything about electronics; but he did, and that he would set the price. He made a major concession by raising the price 20% to \$96,000 which, as I recall, was the face value of the contract.

The other reason could have been that they wanted the patents on this machine, and had it been a cost-plus contract instead of a supply contract, it may easily have been inferred that the patents on this machine would have been government patents, as generally is the case in CPFF contracts.

STERN: Did they retain patent rights?

AUERBACH: Yes.

STERN: Because I've read comments about the stiff patent policies that the government imposed on Eckert and Mauchly, and I don't know what that meant.

AUERBACH: To the best of my knowledge, the patents for UNIVAC I rested with Eckert and Mauchly, and then these passed through the chain of acquisitions to Sperry-Rand.

STERN: So that there really wasn't any stringent patent requirements that the government--

AUERBACH: It was a supply contract.

STERN: Just simply a supply contract. All right. The National Bureau of Standards claims to have given Eckert and Mauchly every conceivable advantage with respect to this contract, to try to help them in whatever way they could. Do you think they did that? Financially, that is.

AUERBACH: Financially, no. Neither were they particularly generous, nor were Eckert and Mauchly very sensible.

STERN: So they really could have contracted for more at that point? They could have even advised them about cost-plus idea?

AUERBACH: They could have when we negotiated for the contract with the Signal Corps. It was a much larger number, but I don't recall the amount. But, my estimate to build the UNIVAC I, very, very shortly after I really got involved in this aspect of the business was--it would take us a million dollars to build this computer.

STERN: That's about what it cost them.

AUERBACH: And it was just not going to be done for Eckert's number at all. And nobody had really figured out how to get the engineering done. The cost of building the machine according to Eckert was \$80,000--and \$96,000 is where he wound up--that was the cost to build it not to design it. Because Eckert wanted to win the patent rights; therefore he wanted a supply contract.

STERN: I see. Can you tell me a little bit about the Signal Corps contract. I know very little about that.

AUERBACH: Ft. Monmouth, the man you should interview is Irving Gableman. And they came down to visit us and they wanted to buy a UNIVAC, and they entered negotiations for a machine. I only was in at the very beginning of that negotiation. I had left Eckert and Mauchly before that contract was ever consummated, or the one with Prudential for a UNIVAC was ever consummated. I was only in at the beginning. I got very friendly with Irving Gableman later on and still maintain close professional relationships with him. He would be best qualified for you to discuss that contract.

STERN: Was that contract eventually executed?

AUERBACH: I don't know. I think it was.

STERN: Was this the Watson Lab Contract?

AUERBACH: Watson Lab is the name of the Lab up in Ft. Monmouth, if my memory is correct.

STERN: And I've seen reference to Watson Lab contracts, but not to Signal Corps contracts.

AUERBACH: Okay. Then check out Watson Lab--I think it is the same.

STERN: Okay--that was definitely a government contract.

AUERBACH: Yes.

STERN: Is there any relationship that you recall between Watson Labs and Teleregister?

AUERBACH: Indirectly. That would be involved in the whole McCarthy era, and when a number of the senior engineers at the Watson Lab at Ft. Monmouth lost their clearance, a couple of them went to work at Teleregister. And one of these was Sam Levine. But that was after '48. That was long after I left Eckert and Mauchly. I left in '49, and joined Burroughs in '49.

STERN: The reason I ask is because many of the interoffice memos refer to the Watson Lab/Teleregister Contract.

AUERBACH: Of that date?

STERN: The '48-49 period, yes.

AUERBACH: Teleregister was designing devices that were digital in character. I don't know more than that.

STERN: So you really wouldn't know about the relationship between those two things. Either Gableman or if I can contact Sam Levine--

AUERBACH: Sam Levine was in the Signal Corps at the time, working with Gableman; or he was on the big radar project. I'm not sure he was working with Gableman, so you may correct that. Gableman would be able to tell you the most about this, and Gableman is at Rome Air Development Center up in Rome, New York.

STERN: Did you do any work on the Army Map Contract? How about the Air Comptroller's Contract?

AUERBACH: No, they were after I left.

STERN: Okay--because, to my knowledge, those were the three contracts which Eckert and Mauchly executed. I don't think the Signal Corps contract was ever executed.

AUERBACH: They never went through with it? There was the Army Map contract. What was the other?

STERN: Air Comptroller's Office.

AUERBACH: I'm not familiar with it.

STERN: Okay. You were directly involved with the National Bureau of Standards contract, however.

AUERBACH: Yes.

STERN: They imposed these checkpoints on the UNIVAC?

AUERBACH: Yes.

STERN: Were they in a position technically to pass judgment on what Eckert and Mauchly were doing?

AUERBACH: Yes.

STERN: They had people with the know-how to do that?

AUERBACH: Yes.

STERN: Now who was really in charge of these checkpoints?

AUERBACH: Sam Alexander. I think one of the engineers was named Ralph Paige. Also John Curtiss. But Paige was the other--they had a couple of very, very bright engineers who represented the government in this.

STERN: And they were somewhat concerned about Eckert and Mauchly's financial position, I gather.

AUERBACH: Oh, absolutely.

STERN: Did the decision to build the SEAC imply any dissatisfaction with the progress Eckert and Mauchly were making?

AUERBACH: One could certainly infer that.

STERN: Okay. Did the design of the SEAC incorporate many of the features that were to be incorporated in a later UNIVAC? Did they learn from this?

AUERBACH: Well, it's almost axiomatic. The answer to your question is clear on evidence. There were two major design activities that were going on in the United States at the time; one at Raytheon and one at Eckert and Mauchly. And the Bureau of Standards certainly had access to all of the design technology that was involved in both. That they decided to build a cathode ray tube memory, a Williams-type memory, was primarily the influence of F.C. Williams from Manchester University who had actually come over and discussed that with Eckert and with the Bureau of Standards and with others shortly after the end of the war. I met F.C. Williams when I was working in Washington on the MARK V IFF system. And so they picked up the concept of the design of that from him, and implemented it. As for the rest of the technology my recollection is that SEAC did not follow some of the basic philosophies in either BINAC or UNIVAC. It was somewhat different. There was also some design work going on at the Institute for Advanced Study by this time in Princeton. Morris Rubinoff, Willis Ware, many, many others.

STERN: Do you recall anything about the National Research Council that von Neumann chaired; that is, the fact that Curtiss went to this committee and asked them to pass judgment on Eckert and Mauchly's computer as well as Raytheon's. You are aware of all that. Can you give me some details on it?

AUERBACH: I can only give you what I knew, which was very little, and that was that they came out with a recommendation that--in fact, (Howard Aiken was also on that committee)--it was impossible to design and build a mercury memory that would operate in a computer. I had already designed, with Brad Sheppard--designed, built and demonstrated such a mercury memory--demonstrated it to Sam Alexander, Curtiss and Paige. I never saw the report but I recall our surprise when we heard about this report. All they had to do was get on a train and 40 miles away in Philadelphia they could see a computer mercury memory operating, and stop conjecturing about the theoretical aspects of things, just come down and look.

STERN: What do you attribute their failure to do that to?

AUERBACH: A great deal of personal animosity.

STERN: Can you elaborate on that?

AUERBACH: Well, you start with the von Neumann/Eckert and Mauchly feud, which eventually split up what was to become a joint venture between Princeton University and the University of Pennsylvania. When von Neumann effectively indicated that he was going to control the conceptual design of the next machine, there was a major rupture among them. And I don't know whether the two men, or three men ever talked after that.

With regard to Howard Aiken, Aiken was really totally unwilling to concede that anybody could have designed anything better than he, at that point in time. Aiken was one of my professors at Harvard. Aiken was a supreme egoist who was totally unwilling to accept the fact that anybody else was designing things that were equal to or better than his own. In fact that's an interesting little story with regard to the relationship between Aiken and Eckert and Mauchly. At Harvard, I was studying a course in applied mathematics with Brillion who had to go to France on some issue, and Howard Aiken substituted for him and taught some of Brillion's courses. And what Aiken did was to switch over and discuss the whole mathematics of series, and pointed out that these were being used in computers, and that's the way problems were going to be solved in the future. That must have been in February of 1947. Some months after that date, I had received a job offer to go to work at Eckert and Mauchly. I came back to Harvard with great enthusiasm to tell Aiken that I was going to come into the computer field. What I desired to do was to spend an extra month or so studying personally with Aiken in his laboratory so that I would be more qualified to go to work for Eckert and Mauchly than I was at that point in time. That was the last conversation Aiken had with me for over four years. He literally would never acknowledge my presence in the class. I would pass him in the street and greet him and he would never acknowledge my presence. And for years after that, I was a non-person, because I had "gone to work for the enemy"--effectively his words.

STERN: He regarded Eckert and Mauchly as the enemy --simply because they were kind of competitors?

AUERBACH: Oh, fierce competitors, as far as Aiken was concerned. Also they had one-upped him. The MARK I

was a mundane but very brilliantly executed piece of engineering. Aiken was a mathematician and he was a very good electromechanical engineer but he was a very poor electronic engineer. He was just one-upped by ENIAC which kind of stole his thunder. He was a man with extraordinary ego--just could not tolerate anybody not considering him ~~the~~ the most eminent computer engineer in the world.

STERN: He and von Neumann would be considered at that period at least in academic circles as the most eminent members of the computer field, it would seem to me.

AUERBACH: I'm not sure I would share that opinion. I think that Maurice Wilkes at Cambridge certainly was far more eminent than Aiken as a *computer engineer*. Aiken did some very brilliant work in designing and building the first MARK machine. He should never have built the second machine, that is, MARK II, and he should have hired some first class electronic people to have them build his third computer. I personally, after joining Travis at Burroughs, went up and saw the work that was being done at the time by An Wang and Way Don Woo on magnetic shift register memories, and recognized that what they were doing was rather marginal electronic design. I came back to Philadelphia and designed, built and had operational a magnetic shift register memory in a computer before they had theirs operating in a computer. Aiken was a very autocratic individual, extremely autocratic. As many credits as I'm willing to give Aiken, I don't consider him to be one of the eminent computer people at that time, except for the design of MARK I. I think that was the major contribution he made to computer development. That, plus some mathematical work in Bessel functions, which was excellent.

STERN: Well, it seemed to me the fact that the National Academy of Science would appoint him to this committee, or ask him to sit on this committee, as well as von Neumann, was at least a kind of implicit recognition of their status in the field.

AUERBACH: There was nobody else of major academic stature around.

STERN: Well, that's it. Especially in this country. You referred to Wilkes, but Wilkes was in England.

AUERBACH: Yes, that's a fair statement. There were a couple of other members of that committee who were electronic engineers, but they were the two computer-oriented people.

STERN: Now, the reason I asked that question was a kind of background question. Do you think, with respect to science and technology, that the eminent people who've made last generation's contributions tend to stand in the way of this generation's contributions, or whether it just seemed to be that way in this particular development? Is it fair to make a general statement about something like that.

AUERBACH: I don't know if I would generalize that much. I wouldn't call it academic individuals --I would talk about them as autocratic egoists. When your ego gets so big that you can't even acknowledge the existence of another organization who's doing work, yes--then I think you have to think twice about their credentials and objectivity.

STERN: So you're really saying it was just this particular personality that handled it that way.

AUERBACH: Yes. I don't think that von Neumann was that bad. I think he and Eckert had a feud. Aiken was the supreme egotist.

STERN: Well, if that's the case, then why didn't he just relieve himself of the responsibility on that committee. I mean, it's not fair--

AUERBACH: Well, von Neumann also had a supreme ego. I knew them both. I guess the only other person in that area would be Norbert Wiener, who was a more modest man by comparison.

STERN: Okay, I'm not sure whether the supreme ego comes from the fact that you're being viewed as an eminent person in the field or not--I mean--

AUERBACH: It has to do with academics. I think academics have a greater need for ego trips than most other people because they don't see that they're getting rewarded through anything else.

STERN: How do you reconcile that with the norm of academia that says you share things and you coordinate efforts and you publish and you do all the things necessary to communicate whatever advances you've made?

AUERBACH: I think they both did that, but what they wanted was the international stature as being the eminent one in their field. I take issue with Aiken, as you did, because as a member of the AFIPS Smithsonian Historical Committee, we tried for years to get Aiken to discuss his work on the development of MARK I with categorical refusals. And I personally talked to everyone who knew him, who could talk to him about this issue, to no avail until he retired, went down to Florida, and I think within a year before he died, he eventually conceded because I think Bernard Cohen had pleaded with him to do an oral interview on tape for history purposes. But he wasn't going to share more than he published.

Another person who could tell you much about Aiken which is not your main area of your interest, and about Eckert and Mauchly, would be Grace Hopper.

STERN: I've spoken a little bit to her, yes. Okay. Part of this NRC report indicated that the work done at the Moore School, the work done at Raytheon, and the work done at Eckert & Mauchly were fundamentally the same.

AUERBACH: There was a great similarity between the work, yes.

STERN: I can understand the relationship between the Moore School work and that of Eckert and Mauchly--but how about Raytheon?

AUERBACH: Technologically, they were kissing cousins. See, you have to start with the state of the technology and the state of the art at that time. And much of that technology came from radar, and the pulse shaping circuits,

and the hardware design was very radar-oriented. They both effectively took off from that vantage point. In fact, Eckert was even ahead of the state of the art working at the University of Pennsylvania while the war was still going on. I think it's to his credit that ENIAC was built and worked.

What other reason would there be behind the similarity? I'm not sure they were identical. They were certainly similar.

STERN: Well, the Raytheon computer, it would seem to me, would be more what we would call today a "scientific" computer, I think.

AUERBACH: Yes.

STERN: And that in and of itself would make a fundamental difference.

AUERBACH: Well, are you talking about the engineering, or are you talking about the logic?

STERN: I'm talking about both.

AUERBACH: Engineering-wise, it doesn't make any difference whether you are building a scientific or a business machine. The circuitry is fundamentally the same.

STERN: Well, engineering-wise, in terms of the I/O devices is really what I was referring to.

AUERBACH: I/O devices in the late '40s were of the most rudimentary kind.

STERN: Well, the fact that Eckert and Mauchly were working on a tape seemed to me to be quite an innovation.

AUERBACH: Extremely so. Extremely so. Paper tape was the best I/O medium we had at the time.

STERN: Are you aware of whose idea that was to go on tape? The plastic and then the magnetic tape?

AUERBACH: I don't know for sure. Metal tape initially was what Eckert worked on. There were three people at Eckert and Mauchly who were working on the magnetic tape project most intensely. One was Eckert, and the other was Ted Bonn, and the third Frazier Welch who is dead. Possibly also Brad Sheppard.

STERN: You say that Eckert and Mauchly approached you to work at their company.

AUERBACH: No, I approached them.

STERN: You approached them. Okay.

AUERBACH: I had met Brad Sheppard at a party and he told me what he was doing, and he invited me to the company to meet with Eckert. So at Sheppard's invitation, I went for an interview.

STERN: You said the major work--at least I assume you meant commercially that was going on in this period was at Raytheon and at Eckert and Mauchly. What about the work at ERA?

AUERBACH: Superb.

STERN: Was there any involvement between Eckert and Mauchly and ERA at all?

AUERBACH: None.

STERN: How about with Raytheon?

AUERBACH: I don't know. I wasn't at either other company. However, it is unlikely because the ERA work was extremely highly classified.

STERN: I meant, did Eckert and Mauchly have any involvement with Raytheon?

AUERBACH: I knew a number of the people there and was responsible for getting Jim Wiener to join Eckert and Mauchly from Raytheon. I knew both Bob Campbell and Dick Block.

STERN: Now, I'm not sure, but was Wiener an electronic engineer at Raytheon? And he came in the same capacity to Eckert and Mauchly.

AUERBACH: Yes.

STERN: Okay--and he had been working on computers.

AUERBACH: Yes.

STERN: I assume this is the way the transfer of technology took place--actually during this period.

AUERBACH: Oh, absolutely. You could trace the technology through the people who moved about. Even predict what the technology was going to look like.

STERN: Did anybody move to Raytheon from Eckert and Mauchly?

AUERBACH: Not to my knowledge.

STERN: I wonder if you can give me a little bit of background information on some of the other employees at Eckert

and Mauchly, like for example George Eltgroth.

AUERBACH: Eltgroth was a patent lawyer; he was hired by Eckert to protect the patent rights that they were developing in the company. His background I'm sure you know.

The best engineers at Eckert and Mauchly were Bob Shaw and Brad Sheppard and Frazier Welch all superior. Plus Al Auerbach--Bernie Gordon--Herman Lukoff. You're talking about some damn fine engineering talent. All top notch.

STERN: And these were not only people that were originally working on the ENIAC.

AUERBACH: Oh, no, no. I was the beginning of a new group that came into Eckert and Mauchly. They found first-class talent. Men who have gone on to make names for themselves, completely independent of earlier work at Eckert and Mauchly.

STERN: Let's consider the Straus relationship: that is, the American Totalisator Company. Do you think that had Straus lived, he would have been able to sustain--provide Eckert and Mauchly with the money they would have needed to sustain themselves?

AUERBACH: No.

STERN: It seems to me that we're talking millions of dollars at that point.

AUERBACH: You're talking in the tens or hundreds of millions of dollars. Millions of dollars they had, but not more than that.

STERN: Okay. What about IBM's role at this point?

AUERBACH: IBM had developed the SSEC, and when the announcement came out, Mauchly literally aged 5 years over night in fear that they had beat him to the draw. We sent a few men up to see the machine. I went up to see it a little later--and it was a Rube Goldberg machine.

STERN: But IBM was always seen from Eckert and Mauchly's point of view as the competition?

AUERBACH: Oh, yes.

STERN: As opposed to any other commercial organization.

AUERBACH: That's because they were developing a computing machine.

STERN: Did Eckert and Mauchly have any contact with IBM? To your knowledge?

AUERBACH: Not to my knowledge.

STERN: It seemed to me that a company the size of IBM, and with their hold on the calculating equipment field, why do you suppose they didn't begin to develop electronic computers prior to this period?

AUERBACH: They didn't believe in it?

STERN: They really didn't believe in it?

AUERBACH: Some electronics work was going on in Watson Laboratories in New York. And they had been doing some other interesting work. The other work that was being done in the early '50s was stimulated by Northrop that had to do with 604, 603, that kind of equipment. But I guess it wasn't until after Thomas Watson, Sr. died that electronics suddenly became a dominant issue with IBM. As you well know--the power that they have since

achieved, and they're entitled to.

STERN: It's amazing that IBM took over from Remington Rand in the short period that they did.

AUERBACH: They understood marketing and nobody--neither Eckert and Mauchly nor Sperry Rand nor Remington Rand--had the vaguest idea as to the power of the systems that they were involved with. And their total blindness from a marketing point of view kept them from being the dominant force in the computer industry. They absolutely were stupid. They gave the field to IBM.

STERN: Why bother to buy UNIVAC--the Eckert and Mauchly division and not--

AUERBACH: They bought both Eckert and Mauchly and ERA. They cornered the computer market when it came to talent at the time. They were *the* company--they had the finest engineering talent in the world in one company.

STERN: It seems to me it would be pretty hard to do what they did--but they did it.

AUERBACH: Right.

STERN: Okay--can you tell me a little bit about Straus' involvement?

AUERBACH: Very little. I was not privy to any of those activities. My recollection is he came in '49 with money. I left the company in early '49.

STERN: I think he came in '48.

AUERBACH: I was just peripheral to his involvement--I had met him. I also met some of his associates. He came down to visit the company a couple of times. But, by that time even though I was still serving as a member of the

Executive Committee, I was no longer privy to what was happening.

STERN: Why is that? Because you were going to leave?

AUERBACH: No it started earlier. I had sided with Mauchly on a critical discussion when we were about ready to go under financially, and did not agree with Eckert's viewpoint.

STERN: Can you give me some information on that?

AUERBACH: We were running out of money, and I guess on one occasion--my paychecks were deposited in the company safe because we didn't have money to cover the checks. The check was written and put into the safe. On this occasion we were again running out of money and I guess it was the time that Eckert wanted to build the UNIVAC and I felt that it was going to take too long and too much money. Mauchly and I came up with the idea of taking the BINAC, slowing it down to a 1 megacycle machine, putting paper tape on it, and building them for people who wanted to work with and learn computers. Eckert felt that that was sacrilegious and literally, chalk and blackboard erasers flew about the room to express his rage. He felt that what we had to do was something just as a quick-fix. He proposed to build spark plug testers for automotive repair shops. He spent the weekend designing a spark plug tester. He came in and started to build it. It was not only futile, but it was a totally wrong approach to the problem. Eckert did not particularly like people to raise a position against him, or question his judgment.

STERN: It's interesting that you mentioned that, because I just finished doing some writing on the BINAC and found a document that Mauchly distributed, saying just what you're talking about, and the following day, coming out with a disclaimer. That is, it's the opinion of the engineers that we stick with UNIVAC design and he subordinated all of this. And it seemed to me, at that time, that therein lay a particular problem that led to the demise of the company, because had they just set their sights a little lower, things might have worked out better for them.

AUERBACH: It was a 5-man group who made that decision. Eckert, Mauchly, Gene Clute, Wiener, and I. We met at

Eckert's home that night. Wiener always said "Yes" to whatever Pres Eckert said; it really made no difference what it was, he was a "yes" man. Clute was ignorant. Mauchly was a dreamer. And I saw it as a practical solution as to how we were going to survive. I guess at that tender age I didn't know what it was to take opinions contrary to the boss's, but I did, and it did me in. Eckert cut me off like a limb from a tree.

STERN: How about the relationship between Eckert and Mauchly? Could Mauchly convince Eckert of anything?

AUERBACH: Yes, in the area of mathematics or logic.

STERN: But in other ways?

AUERBACH: None.

STERN: What was the purpose of allowing Mauchly to be President?

AUERBACH: Eckert was too young. Eckert's father funded the company. Eckert didn't want to be bothered with all this outside nonsense. He wanted to build computing machines. And it was a marriage of convenience that was brought about by the difficulties with Brainerd at the Moore School of Electrical Engineering at Penn. The two felt that they needed each other in order to get this company launched. I think that--there was no love lost between the men personally, but there was a respect for their professional competence.

STERN: What actually, would you say, did Mauchly contribute to this organization?

AUERBACH: He understood the mathematics of the computer and logical design, systems and applications design. The concept of numbering system used, I think, was certainly attributed to him. Conceptual design of the machine. Now, how much of it was his and how much of it was Shaw's, or Eckert's, I don't know. But Mauchly certainly addressed those issues.

STERN: You said, before, something about Mauchly being an applications person; that he understood the kinds of applications and kinds of uses you can make with computers. I assume that's what you meant.

AUERBACH: Yes--he understood the mathematics of computers, and he understood the kind of thing that BINAC could be used for. And that was well within his comprehension.

STERN: What about the very fact of going to the Census Bureau? It seems to me that that was a pretty innovative thing to do.

AUERBACH: Hollerith had been there before so it was really just following what everybody knew, that problems existed.

STERN: Just a little bit more on the relationship of the two. More often than not, Mauchly was willing to subordinate his opinion to Eckert's, then?

AUERBACH: After the showdown I described, Eckert became the dominant influence in the company.

STERN: And he wasn't up until that point?

AUERBACH: He left much of it to Mauchly to do, although he was totally responsible for the engineering. He left much of the rest of the company's activities to Mauchly to run.

STERN: And after this, he was less willing to do that?

AUERBACH: He felt that since Mauchly wanted to do something different than he wanted to do, therefore he was not sure of his judgment. Since his father was funding the company, or at least partially at that point, he started to

speaking up more, but with no greater business competence.

STERN: Is this a characteristic of engineers--this focus on creativity--this "Babbage syndrome" that I tend to call it?

AUERBACH: No.

STERN: Or you think it's, again, just an isolated personal thing?

AUERBACH: I think that there are many of us who were there at the time who were first class engineers and have gone on to run very successful companies.

STERN: It seemed to me, for the ENIAC he was perfectly willing to freeze the design; I guess it was a wartime necessity--

AUERBACH: You'd better go talk to Herman Goldstine about that.

STERN: You mean that he was less willing than it appears on paper?

AUERBACH: Herman Goldstine would tell you that he was the one that froze the designs and froze the issues or they were not going to give them more money.

STERN: But that had it been up to Eckert, they would have--

AUERBACH: I don't know. I wasn't there. I'm only telling you what I heard. This is purely hearsay. I've been trying to distinguish between what I know from first-hand knowledge, and what I have heard.

STERN: I understand. In terms of Straus's involvement, did Straus set any guidelines or make any requirements?

AUERBACH: I've indicated that my contact and association with Straus was absolutely minimal. I'm unqualified to discuss it. I just don't know.

STERN: Okay. How else did the company seek funding? Eckert-Mauchly?

AUERBACH: I can't tell you the details since Clute and Mauchly, and some of Eckert's time was spent on this issue. I don't know where else they went.

STERN: They didn't go internal--I thought they did go internal through the company to find out if people were willing to buy stock from '47 on.

AUERBACH: I don't know. None of us new-comers could buy stock, up until the time I left the company.

STERN: I thought Brad Sheppard owned some stock.

AUERBACH: Perhaps the original group who came into the company from the U. of P. owned some.

STERN: But other than that, there was no--

AUERBACH: I think Brad did, Shaw did--the original group maybe but none of the rest of us who came in later owned any stock.

STERN: I think T. Wister Brown did--

AUERBACH: Maybe? I must admit--I was a novice financially and I didn't have any money. So...I wasn't the least bit interested because I couldn't afford to buy stock if it was offered to me. To the best of my knowledge, neither Lou

Wilson, nor Jerry Smoliar, nor Al Auerbach owned any stock in this company.

STERN: What was the relationship between Eckert and Mauchly and the Census Bureau? Did they deal through the Bureau of Standards?

AUERBACH: Yes through the Bureau of Standards.

STERN: Essentially were you involved with McPherson and Hansen?

AUERBACH: I met them. They came and visited us and they saw what we were doing, but the Bureau of Standards were the contract monitors and the contract officers. McPherson I got to know better and knew Hansen. We went to lunch with them, showed them what we were doing in detail, but the dominant influence was the Bureau of Standards.

STERN: And the technical decisions then were left to the Bureau of Standards?

AUERBACH: Yes.

STERN: Were you involved in the early years of ACM?

AUERBACH: I attended one of the earliest meetings of ACM; it took place in Philadelphia in--

STERN: I think '47 was the first.

AUERBACH: I wasn't at the '47 meeting.

STERN: Then there was one in '48.

AUERBACH: I was at the '48 meeting.

STERN: You were one of the original people involved with ACM.

AUERBACH: I was not one of the founders.

STERN: Right.

AUERBACH: I was one of the founders of the IRE (now IREE) computer group. I took the lead and was the founder of the Philadelphia Chapter of the IRE Computer Group. I was one of the founding members of AFIPS, but not ACM. Later I founded IFIP.

STERN: Is it fair to say that one of the reasons that the founders had in mind for forming such a society was for transfer of information, to provide some vehicle for that, because there was a need for it.

AUERBACH: Yes. Ed Berkeley. And Bob Campbell, who was at Raytheon. And Clippenger. This history is all written down... No point in my trying to re-create things you either already know or you can find out with greater accuracy.

STERN: How was information generally transferred?

AUERBACH: Orally. In 1948, I convinced Eckert and Mauchly to give one of the first papers on computer development that they ever released, and that was on the mercury memory. I presented it to the IRE, at the IRE national convention.

STERN: The standard route of publishing papers was not something that was done with any regularity at that time?

AUERBACH: No. Everybody was concerned about patents, so you didn't publish because you were concerned about public disclosure. Most of the information was by word of mouth.

STERN: This situation--this hesitancy to publish--is this characteristic of engineers in an environment where there's new technology, or was it something specific to computers during this period?

AUERBACH: I think it's characteristic. People don't want to publish until they feel reasonably sure they have patent coverage. Otherwise, public disclosure can give somebody else the lead, and patents are only as good as your ability to defend them. And so if you wanted a couple of years lead time, you didn't go tell everybody what you were doing.

STERN: Which makes the transfer of technology somewhat difficult in that period.

AUERBACH: Oh, we did it very, very actively by hiring people from another company.

STERN: What about--did you have any dealing with any of the academics working with computers during this period?

AUERBACH: Yes. At Princeton--with Morris Rubinoff.

STERN: Well, how do academics reconcile the fact, as I asked you before with respect to von Neumann, that you're supposed to publish; you're supposed to be concerned about transferring information--

AUERBACH: They were publishing.

STERN: The academics were?

AUERBACH: The Institute for Advanced Study was publishing the dominant papers in the industry at the time.

STERN: It's just the engineers working in the commercial organizations--

AUERBACH: Oh, the commercial companies did not believe in publishing extensively.

STERN: But then ACM was predominantly a commercial organization, at least in the beginning, from my understanding.

AUERBACH: Yes.

STERN: So that even--

AUERBACH: The papers you gave were very carefully scrutinized. In fact, I'm sorry that you don't have a tape recording of the 1948 meeting of the ACM. The debates that went on openly on the floor of the meeting after a paper was presented were fierce. They argued as to whether or not the speaker was telling the truth.

STERN: Really! And you say this is characteristic of any technology--

AUERBACH: No, I don't. I'm only telling you what happened in the computer field. I'm not going to try to extrapolate from that.

STERN: Okay. What about some of the conferences that occurred during this period? Did you attend very many of these in the '40s?

AUERBACH: There were very, very few conferences in the '40s.

STERN: There were a couple at Harvard, I think.

AUERBACH: I attended none of those. I was persona non grata with Aiken, so I didn't get invited to any of the Harvard conferences. I did attend one while I was a student, that was held on the Harvard campus.

STERN: That was the '45 one?

AUERBACH: No. 1947 I think. There was a conference at Penn; and I believe there was a conference at Harvard. These were to tell people about the computer--what was going on with computers, and what you could do.

STERN: And essentially--

AUERBACH: Report on what had been accomplished. And these were the first times that MARK I and ENIAC were described. EDVAC, too.

STERN: In '47 people representing the industrial community were willing to make some sort of presentation of this.

AUERBACH: I do not believe that Eckert and Mauchly published any papers after they left Penn until--I think the first commercial paper was the paper that I wrote with Eckert, Shaw and Sheppard, in the fall of '48. Is that correct?

STERN: I think so, yes. I'm not certain about the date. I know that was the first paper.

AUERBACH: Yes. That's the date. It was March of '48. It was at the time of the IRE conference in New York which was always the end of March.

STERN: I thought it was in a later year.

AUERBACH: No--no. 1948.

STERN: Was that paper presented at the IRE?

AUERBACH: Yes, I presented it. I remember I went out and bought a hat to try to make myself look older.

STERN: In terms of internal correspondences--I know that they had these interoffice memos and so on, but was this an effective method for people within the company to communicate with one another?

AUERBACH: No. You communicated by having lunch with people. You described what you were doing on napkins, and the primary mode of communication was oral.

STERN: And none of it was written down, at least at that point?

AUERBACH: Some of it was written down, primarily for patent purposes.

STERN: I see. Did you have any dealing with the Nielsen contract at all?

AUERBACH: None.

STERN: Nor with the Prudential?

AUERBACH: No.

STERN: And Eckert and Mauchly did have these contracts with Nielsen and Prudential--they were kind of like study contracts.

AUERBACH: Yes, but I was not involved with them.

STERN: You did not have any dealings with Berkeley at Prudential.

AUERBACH: I knew him socially--he came to visit us, but I had no business dealings with him.

STERN: Okay--so essentially--

AUERBACH: We were very compartmented as to who we dealt with. I dealt with Alexander and Paige and Curtiss, because I was concerned with the memory and NBS and they were financing my project.

STERN: This compartmentalization--was much of it the result of particular problems you or anybody else had with Eckert, or was this just the way the company operated?

AUERBACH: That's just the way it was.

STERN: They were very much afraid of other people taking ideas and going to other companies?

AUERBACH: Yes, let me give you an example. I was familiar with what Ted Bonn was doing in the bathroom in the original lab on Walnut Street. He was building a plating system to plate magnetic tape. It was forbidden to know anything more than that he was working on a problem involving magnetic tape. Nobody was allowed to go in and see what he was doing or anything else.

STERN: And yet you hear about this wonderful relationship that all the people at Eckert and Mauchly had with one another.

AUERBACH: Socially--and the fact that we were all out in the avant garde and deeply concerned about the future--

yes. From that point of view, it was a very, very warm relationship that existed among the people. And if you wanted to talk about what we were going to do on the next machine and things like that--yeah. But what the chemical composition was that was being deposited on the metal tape--or about the crystals that were being used in the memory tanks--no.

STERN: Why specifically did you leave?

AUERBACH: I had a single altercation with Eckert and he made me feel like an outsider. I guess I also felt that the atmosphere and the lack of business sense that was evident indicated to me that the company was not going to make it.

STERN: Despite the fact that at that time some of the most exciting work was going on over there.

AUERBACH: Yes.

STERN: You then went directly to Burroughs, is that right?

AUERBACH: No. I had a job for a few months making memory cathode ray tubes, but found it terribly boring.

STERN: When you were at Burroughs, did you work with Travis at all?

AUERBACH: Oh, of course, he was my boss. I was the third person to join Burroughs Research Lab.

STERN: First was Travis?

AUERBACH: Travis was first, and there was a young man who was from Penn. And then I was hired, and then Joe Chedaker, and then a couple of other people from Penn were brought in.

STERN: Okay. Travis himself came, I think, in 1948.

AUERBACH: Yes.

STERN: He must have had some very kind words to say about Eckert and Mauchly too, I imagine.

AUERBACH: Yes.

STERN: Okay--I'll turn this off. Thank you very much.

END OF INTERVIEW