

An Interview with
JAMES T. PENDERGRASS

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Conducted by William Aspray

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Abstract

Pendergrass discusses his work in the Navy and the early use of computers there. He discusses his decoding and production work during the second world war, particularly on the Enigma project in which he used IBM, Kodak, and NCR equipment. After the war Pendergrass remained in the Navy and worked with Rear Admiral Leonard Winger and others in the Naval Security Group. Pendergrass reviews his computer training in 1946 at the University of Pennsylvania Moore School for Electrical Engineering and his subsequent work for the Navy with Engineering Research Associates, the Institute for Advanced Study, and IBM. He concludes with a discussion of his Navy work on the Atlas project and advances in computer technology in the late 1940s and early 1950s.

JAMES T. PENDERGRASS INTERVIEW

DATE: 28 March 1985

INTERVIEWER: William Aspray

Location: Princeton, NJ

NOTE: Approximately the first five minutes of this interview are missing. The interviewer had difficulties with the tape recorder.

PENDERGRASS: ... and of course they needed people in the communication watch standing more than they needed aeronautical engineers because they didn't have any air field. They had a tender and a couple of sea planes operating from the tender, which was completely self-contained. So one of the aeronautical engineers went to Bermuda, went into ? the car, automobile transportation, and I went into code-breaking, the communication watch. I arrived there about the 1st of October 1941. I had just taken over the watch and was on duty all day Sunday, December 7, 1941. So that was a little excitement. We had a lot of exciting days because at that time only commissioned officers were allowed to handle the encryption-decryption devices. After two years in Bermuda I decided I wanted to see more of the war so I wrote a letter saying why I should be designated a communication specialist in the Reserve rather than an aeronautical engineer, that I was suitable for advanced duty in the Mediterranean or the European theater. I stated my credentials, my mathematical background. At that time Howard Engstrom was assembling mathematicians for the security business and I was forthwith. Somebody in the Bureau saw this and said "here's a guy who's had general service communications equipment and coding experience and he's got a mathematical background". Engstrom said, "send him." So I came to Washington in June of 1943 and was put to work on the Atlantic problem, which as you know is the German Enigma. Joe Eachus was back from England and was assigned to teach me the business. I relieved Howie Campaign on watch, took over his watch, after three or four weeks. You can learn an awful lot in a concentrated way if you're working eight full hours a day with somebody who knows what he's doing, which Joe did. So in three or four weeks I took Howie's watch and he went out days to work for Engstrom in R & D.

ASPRAY: Can you tell me something about the nature of your work?

PENDERGRASS: Production, it was production. We did one hell of a lot of production. The only book that I have

seen that gives a reasonably true picture is [Andrew] Hodges' biography on Alan Turing. Hodges actually comes closer, in my estimation from my bird's eye view. We had traffic and it was our job to turn it into plain language. It's as simple as that. There were lots of processes which needed to be done. It was a reasonable amount of brain work; but it was not original type research where you try various ideas. It was outsmarting the people with glibness.

ASPRAY: You had electronic...

PENDERGRASS: [Laughter] Oh, I'll say we did. We had first the so-called bombe. I don't know how many; I can't give you the exact number. Not because of classification; it was a large number and they did keep arriving...

ASPRAY: Were these of American design?

PENDERGRASS: These were definitely American design. They were built by National Cash, as you probably know, in Dayton, Ohio. They were good production-type, non-experimental type machines. I also had later experience with the British because I did go to England, to GCHQ, later in 1944. But these bombes were designed and built with all the knowledge that the British had, and they were built by a first-class company who really knew how to build these kind of things that will work. They were very good, very reliable. They were operated by what seemed like hundreds of Waves (women). The whole bombe operation was essentially in the hands of women. Early on there were one or two male watch officers over in the building, but the rest was all women.

ASPRAY: Where was this located?

PENDERGRASS: This was Nebraska Avenue. It was in Building 4 and we were in the old School. They were in the new building. We were in the library or lounge of the Mt. Vernon Seminary for girls which the Navy bought and moved to sometime in 1942. (I think it was then; it was before I got there.) The bombe work was done by the Waves. Early on they were not told specifically what they were doing. They did what they were told. The set-up was sent over to them, i.e. how to set up the bombs and what to do. They put the wheels on the bombes and made the runs. They did some checking of the prints that were printed out before they sent them over pneumatic tubes back to us. We checked them out against the other text to see whether ? . So, there was no brain work done over in

the bombes. The hours were drawn up under the watch officer ? group. Whether the thing was broken was a combination, of course, of ? and high-speed trial-and-error on a machine. Hodges has a good description of the machine and how it was broken--much better than that of the people who were on the intelligence end, who just said it was all magic. Some of those books were dreadful. We did all that Navy Atlantic stuff. We eventually took over it. I mean these bombes came in and we took over. The British concentrated more on the traffic which they could hear that we couldn't hear. Finally, we had more capacity in the traffic that we could receive and so we started doing Army and Air Force runs. This was pretty much stooge work. I mean they sent over the text that was needed and what groups were needed, and we just sort of drew them up and ran them and tested them. With they Navy stuff we did a little more brain work. You've got to divide cryptanalysis into (search?) where you have an unknown system and you've got to find out its aspects, the parameters. You may have some clues because you knew the designer and you know what he has in mind and what country he is from. You know that they go along and they move along in what progression. So you can sort of guess what may come next with this sort of thing. This was a known system, we knew about it. But we had to find ways of doing it faster. This is very perishable intelligence. You work on things very, very fast. It's not like diplomatic or economic intelligence which goes over long periods. If you didn't get the information out to a convoy, in time to divert, you'd have a bunch of submarines lying in wait for them that intelligence isn't much good. So there was a lot of heat on. Of course we worked 24 hours a day. The people at the other end, the intelligence people who handled this, worked 24 hours a day to put out messages to the fleet on a 24 hour a day, 7 day a week basis. It was all very exciting actually. I hate to say it, but the war was one of the high points of my life.

ASPRAY: That's not at all uncommon.

PENDERGRASS: I mean when you did something that used a little ingenuity and got out something in time to get a submarine sunk just before it came out into the open Atlantic, which I did on one occasion, and it was a submarine tanker...to watch the Germans for three months later trying to arrange rendezvous with this tanker we knew had been sunk...those poor bastards that went to the bottom of the sea... It's one of those things.

ASPRAY: Who was on the research side?

PENDERGRASS: The research side? There wasn't too much research on the Enigma during this period. It was really operations. I mean Turing had left, Hugh Alexander had left ? . A guy by the name of Pat Mayen, who was a real young fellow who was in charge of about eight. On our side, there was Warren Randolph Church, who was a professor of mathematics at the Naval Postgraduate School in charge. He worked days and was the continuity. He was a professional mathematician who got very much interested in computers. He moved to Monterey [site of the Postgraduate School]. After his retirement, when they moved him out of his office, he went up to the roof and shot himself. Horrible. That was Church. The research side, of course, was under Engstrom. By this time the operations had long since parted from Engstrom and were under people of not much technical knowledge. Under Engstrom there was Andy Gleason in the mathematics R & D, Al Clifford, Bob Greenwood, Howie Campaign, for a while Oswald Jacobi, the bridge player and the most conceited man in the world. He had a tremendous brain but he never did much ? . That's another very interesting story about Jacobi, but I'm sure has nothing to do with computers so I won't bore you with it. I guess Ed Moise moved there from operations. These are all mathematicians except Os Jacobi who dropped out of school in the eighth grade. Later I suppose Don Miller came back but not during that period. Oh, Marshall Hall. Marshall was there all the time. A very good name. Joe Eachus was there when he was not in England, but he spent most of the war in England. That's all the names that come to mind. But they worked on all of business and as I say by the end of 1943, the Enigma was not a research problem at all. It was up to us to figure out how to cut down the number of wheel orders we had to try. We had beautiful schemes on how to cut, to limit the (stackers?). The Germans did things very methodically and somebody decided that you shouldn't use the same wheels two days in a row. Well, obviously that's a great advantage once you know this. Once you've observed this because you don't have to try those same wheels in the same positions. Also, they did things by hand-random, they selected things by hand-random. If you've ever studied hand- random, you know that it is not random. For some reason 1,3, 5, and 7 are much odder numbers, much better random numbers than 2,4,6. All those sort of things, and we played those games with them to cut down our trials. So we never had to try all the possibilities. We could cut down our efforts.

ASPRAY: In the research group was there much effort to develop new equipment for problem-solving?

PENDERGRASS: Well, there was another group that did, yes. Larry Steinhart and John Howard built some new equipment. They built a little new equipment for the Enigma problem. It was actually for the German Army and Air

Force [decoding]. The German Army and Air Force did some things that tried to make their system tougher and some equipment was designed for that. But I don't believe it was ready and in operation by the end of the war. In spite of this sped-up system during the war, it still takes time to convert ideas into hardware. I don't know how much they did on the Pacific side because I personally was not involved. As I say, by the time I got to England, probably the end of October of 1944, England was definitely in the hands of the third team also as a caretaker operation. The big boys had gone over to newer systems, on-line type systems, teletype systems, and that sort of thing.

ASPRAY: Is there somebody who could tell us about that?

PENDERGRASS: Again I go back to Hodges. Max Neumann was in charge of the Numery. Ask Howie Campaign. He was over there. He lives in Portales, New Mexico. I can get you his address if you like.

ASPRAY: That would be useful.

PENDERGRASS: You can read about it in Hodges. Turing as you know of course went off completely from this type of activity and was doing some voice research, completely divorced from what was then GCNCS.

ASPRAY: Do you have confirmation of this independent of the Turing book? I just wanted to check the book by somebody rather than Hodges.

PENDERGRASS: I don't know of any inaccuracies in the book. There are a little bit in the Enigma that I put in a little. Of course he's an Englishman, so everything done by England gets the first crack. But there's nothing that I can refute very well in there. But I was in England. Howie Campaign was an old friend of mine. He worked in the Numery and took me on tours over there. I saw all this sort of thing. There's nothing that I read in there... Turing was gone when I got there and I knew he was off the force and that he was in some kind of speech research. I never knew he was a homo sexual, incidentally. I knew he was an eccentric and I heard the story about his counting the revolutions of his wheel so that the chain went off. That's an old story that's been around. There was still a fair amount of Turing legend when I got there. The only time I talked to Alan Turing at any length was when Howie Campaign and Joe Eachus and I went to Harvard for a computer convention which would have been probably in 1947. Alan Turing was

there and Joe knew Alan Turing pretty well. So Joe invited Turing over and the three of us, four including Turing, sort of quizzed Turing about what the British was doing in this. He apparently still had some connection with GCHQ at that time, whether it was simply a personal connection with some people or whether he was a consultant, or what, I don't know. But he told us that he thought we were very smart to be getting in on the ground floor and to be doing a lot of work in computers. We talked a little more freely than we possibly would because of his background. We did tell him some what we were doing and he said we were very smart and that he had tried to sell GCHQ on this idea, but for reasons of money or what have you, maybe they just didn't want to deal too much with Turing. They thought Turing was trying to sell them on this National Physical Laboratory scheme and wanted support for that; but apparently they gave him the cold shoulder. That was his impression. But that's getting a little ahead of the story. We had other equipment at Nebraska Avenue which for some equipment, the bombes were very special, very special equipment. They were designed strictly for the equipment and of no use in any other connection.

TAPE 1/SIDE 2

PENDERGRASS: There was of course a large IBM section of, but I didn't have much to do with that.

ASPRAY: Punch card tabulations?

PENDERGRASS: Punch card, right. As far as I know, IBM didn't make anything that wouldn't use a punch card in those days.

ASPRAY: I guess that's right, though I understand they were subcontractors to NCR in building some of the mechanical equipment in Dayton during the war.

PENDERGRASS: Oh really? I never knew that. Of course, Howard Aiken. IBM participated in that. But we always had the feeling that IBM wasn't really interested unless a machine chewed up a lot of punch cards. But that's neither here nor there. Their other type of equipment was for statistical purposes, counting and looking for repeats or patterns. A famous example was that of Vannevar Bush designed back in 1938 or so...

ASPRAY: Differential analyzer?

PENDERGRASS: No. This was a special purpose, digital piece of equipment that used optical comparisons on tapes that went by lights. When some conditions were met, it would stop and test it. As the story goes, Lieutenant Winter who became Rear Admiral Winger, which was the guiding light of the naval security group during WWII in spite of several other people being bosses. He is supposed to have gone up to MIT and talked to Vannevar Bush. Bush immediately had this idea and some ? went back and apparently never told Bush much about whatever happened to it. He got the equipment built somehow. I don't know how, that's before my time. But it was still around and operating and about 1946 or 1947. About then I was sort of Winger's pokey boy. I was sent down to deliver a letter to Mr. Bush, Professor Vannevar Bush, who was at the Carnegie Institution at the time. This was a classified letter which Captain Winger did not wish to leave lying around in the files. He was going out a little bit on a limb because Bush had no clearance for our particular business. Of course, his war-time clearance was well known; what he was involved in was well known. But Captain Winger invited him to come out to see the equipment that came from his brain. I delivered this letter and sat there while Bush read it and pencilled out a reply to give to me that he would be delighted to come. So, I went down there with a Navy car and picked him up and brought him out to Stein? and I went around and showed him Captain Winger's new shipment of equipment. He was tremendously interested in all the equipment we had. He asked a lot of questions. He stopped and he had to figure things out and see how it worked. I was involved in taking congressional people around, but nobody like Bush. This was digressing a little bit. But, Vannevar Bush was in it. I haven't read that anywhere. But that is known. I can't see why it should be classified. The equipment that he designed is so antiquated, so out of use; it must have been retired by 1950 anyway. It probably should have been retired earlier. I think it was called the Comparitor because what it did was it matched tapes and, when the right holes went past the photoelectric reader, something happened.

ASPRAY: I understand that Eastman Kodak also built equipment.

PENDERGRASS: Kodak also had equipment and, of course, Kodak was interested in film. So their techniques involved film and also collection of light. Now, here you have something that's possible, the finger-push design was strictly digital, discrete. Well, I can't even remember, I never used the Kodak equipment. They did have one device where you would measure the light so you sort of had a summing up by measuring the total amount of light that went

through. I mean you represented things digitally, but you didn't have to count them individually. You counted them if so much light got through..

ASPRAY: I see.

PENDERGRASS: So, there is a powerful idea. Because you really don't care which individuals were counted sometimes. You may want to know just how many or whether it passes a given threshold. Then you've got to examine it by hand anyway. Yes, Kodak was also involved. IBM was involved. IBM was always very hard, very difficult. Not everybody would tell you this, but they were. They were interested in things which had, from their point of view, commercial application. They didn't want to tie up R & D people. On the other hand, when Captain Winger got to speak to Thomas J. Watson, Sr., who was a very patriotic individual, he got results. But, the story was, whether it's true or apocryphal, the IBM people tried to keep people away from Mr. Watson because he was so patriotic and would promise the government all kind of things. Whether that was true or not, I don't know. But for a while IBM did not play ball too well on R & D. Relations were very good with the tabulating and punched card people, but R & D wasn't really... This was the reason: if IBM, Kodak, NCR, NCR phased right out...

ASPRAY: At the end of the war.

PENDERGRASS: I don't know why NCR didn't want to go on, but they didn't. If one or two of these big companies had really cozied up, there never really would have been a need for ERA. But, they all had their fish to fry and they didn't make that much money, I guess, on these code-breaking machines. They had so much pent up work that they wanted to do in the commercial world; they had been on military stuff for so long. There wasn't any feeling of anti-militarism at that time, it was simply a matter of commercial opportunities for a while, better or more lucrative opportunities. There was still a very strong feeling that all of this digital manipulation of data that we wanted to do was somehow different than what commercial entities wanted to do. That seems stupid right now because of course that's not true at all. My one great claim to fame in the computer business was that when I was exposed in 1946 at the Moore School, I said, "my God, this isn't a computer. This is a logical, digital machine which is being worked into doing mathematics. It's being perverted into it. It really was built for manipulating discrete data. And it's being perverted into being called a computer. The name 'computer' is wrong. This isn't a computer. This is being used as a

computer." The ENIAC was of course designed as a computer. It was digital and it was designed thereby. But the von Neumann ideas and the Eckert and Mauchly ideas were logical. That was the one thing that I saw and I remember telling Howie Campaign about this. I said, "you know this is just absolutely ideal for our business. It's better for our business than it is for the mathematicians." Because you had to go into all difference equations from differential equations. You had to go into binary and convert whereby we'd been working in binary for years. That was the purpose of my paper in October of 1946.

ASPRAY: May I ask you to fill in some details here? As the war ended, and we came into peace time, what happened to your own personal career?

PENDERGRASS: Well, I came back from England in September of 1945 and there were a lot of people waiting to get out of the service. I had enough points, but I'd had such a great time that it looked like a great thing to do, so I didn't want to get out of the service. But at that time there still weren't any plans for regular service for this work, whether it was going to go civilian or what. We generally felt that we couldn't just drop this business. Winger tried his best to keep as many people around as possible by saying he was working on setting up a specialty within the Navy, which he indeed did. But I don't think that I was even able to apply for regular commission until perhaps 1948. I've forgotten when my first regular appointment came, when I was finally regulated. It may even have been 1949. These things take time. The Navy was a sea-going operation and they didn't like the idea of specialists. Besides this wasn't a specialty which could be advertised loudly, although there were some very important people who were very impressed. There were a lot of people though who didn't have enough points to get out. (There was a point system based on how many months you'd been in and that sort of thing that established the order of getting out.) There were a lot of people around there just doing nothing, drawing pay. I was put to work writing some kinds of documents on history essentially.

ASPRAY: Anything to do with computing?

PENDERGRASS: Not really, no. I wasn't thinking in terms of computing at all at that time. I was thinking in terms of making machines for cryptanalysis. But then I got transferred to the Mathematics R&D section after about 3 months of fooling around writing stuff and working for Howie Campaign who had been set up. Incidentally, it was very clear

that the Navy was going to hold the line on age for commissions for those who wanted to stay in. Howie was too old, Joey was too old, I think both of them would have stayed in uniform. Marshall Hall would not have under any circumstances, but some of the others would have. I was young enough so that what the Navy wanted was the people they took into their regular Navy to be roughly the same age as the Academy graduates and anyway able to complete a complete career before the statutory age requirement, which is 62. So if you were 32, which doesn't seem like any advanced age, and an ensign you had no chance. If you were 35 or 37 you had very little chance anywhere because of this. So for Howie and Joe the handwriting was on the wall. Winger kept us pretty well informed on his negotiations to set up the specialty. They set up civilian jobs, and Howie and Joe both took civilian jobs. Some of the other people did as well, Frank Royden, Bill Norris. I guess Bill Norris ? ? or he slated to go to ERA although, I think he has a short stick, maybe he was still in uniform when he left, I don't know. Could go to him, right? But, he was in another area and I really didn't know him. I'd met him along with Charlie Tompkins, but I knew Tompkins a little bit better earlier. I knew him when he was with ERA because he got ??? But, he? was in the radio section. We had research on radio reception and all of these other areas which were non- digital. That's where Bill Norris was. He never was in really in the digital cryptanalytic work.

ASPRAY: You came out with what rank?

PENDERGRASS: I was still a Lieutenant. I made Lieutenant Commander on the 3rd of October 1945. They held up promotions to Lieutenant Commander until a large number of people got out, I guess, I don't know. But, it's a funny time to have a big mass promotion, two months after the war was completely over. But I was a Lieutenant Commander and I went to the Moore School in the summer of 1946. There's another name you should hear? Winger wanted to set up a staff research person, sort of to fill the bill that Howard Engstrom had had when he was there. He started to set up the staff before he could find a man to head it. The first one he got was a guy by the name of Scott Blois. He was Lieutenant Commander. He was class of '42 at the Naval Academy, which means he graduated in December of '42. There he was slightly junior to me. He had been sunk on a ship, I'm not sure what ship it was now, I've forgotten. With people who were rescued the Bureau had a policy of giving them their choice of shore duty for the time being, anyway, so that they could get their bearings back before they put them on a ship again. If the guy requested a ship immediately, I suppose they would have put him. Scott was a very bright guy and was going to go into the Naval Academy (and was not a particular star in the Naval Academy either). He figured out that there had to

be a cryptanalytic section of the Navy, although no one was able to come across it. That's what he wanted to do. The Bureau knew where it was and they sent him out there. Now, if you stop and think about it, the number of Naval Academy people that we had in the Naval Security Group, CSA or CSAW or LDPAC or any of the other organizations, was certainly at peak was less than a quarter of a point percent. It was a very, very small number. Winger, Dyer, Mason, Wright, Dennis, and there were few younger ones, but you could count them. There were maybe 15 or 20 and this organization was burgeoning, but it had all been done with reserves. So when Winger decided to go through with his plan here was this real regular Navy type, so he took Scott into the front office and he set him up on the staff of R&D. Winger kept the job as head of Research Naval Security Group as an additional job besides being now head of the Naval Security Group. Twenty G he was, and also a Twenty GL. Blois was his right hand man. It was Scott Blois who did the leg work to try and set up this R&D program. It was Ed Dingley, a controversial character, who was in charge of the radio research. There was Joe Eachus who was in charge of the end of the machine research. There was Howie Campaign who head of the mathematical research. While I was on vacation, late in June of 1946 at my wife's parents' home in Pleasantville, New York Scott called me up and said, "How would I like to go to the Moore School of Electrical Engineering starting next week?" We'd gotten a position in it from the Office of Naval Research, which was sponsoring it. I said, "Of course, I don't want to go. I'm on vacation. I'm on leave!" He twisted my arm a little bit and said that we ought to have somebody there and that I was the logical one. Although he was slightly junior to me, I knew he was speaking for Winger, the big boss, so I naturally said, "Yes, sir," and I went. But, it was Scott who thought that there was probably something in this digital computer business and he wanted to send somebody. So that's how I got to go. I had to end my leave and come back and find out what it was all about. I went without proper orders, on verbal orders, which were to follow. It was always a dangerous thing in the Navy to do something on verbal orders, pay for your transportation and such. But the official orders did come through eventually and I got paid and all that. But, it was ? . One more word about Scott Blois, a very interesting guy. He decided he wanted to go into research and he set up a program to send people from the Security Group off to civilian universities to get a Ph.D. in programs of their own choosing. The Navy's PG system didn't have anything like this, but they managed to work it and the first guy we sent off was Bill Blankenship, a respectable mathematician, who did manage. He had been a star at the University of Virginia. He'd done some very good work. He managed to come to Princeton and get a Ph.D. in two years. You always start off by sending your best man. Church was head of the math department at PG school, which was then still in Minneapolis. ? and I ? with ? and got a program set up and got Blankenship approved, provided he could get in on his own merits to the

school of his choice, Princeton, which he did. Then, we sent Pat Billingsly. Pat was a Naval Academy graduate who was toward the bottom of his class, but he had written an English thesis on mathematical logic and we got the word that this kid wasn't allowed into the Navy unless he got into some specialty. So, he was sent to us and did some good work with us. We sent him off to PG school and also to Princeton. It took him about a year after he got back to get his Ph.D., but he did. Now that we got the program all set up it was time to send Scott Blois to graduate school. He managed to get into Stanford; he was a San Francisco boy. His father was a Vice President of Bank of America. He wanted to take physics, Billingsly in statistics and Blankenship in mathematics. There was another character in there. But anyway Blois went out there and despite the fact the Navy gave him a year or two after and gave him a third year and a year or so after to work on his Ph.D., he still didn't get it. But, he talked his way into going to a Naval Laboratory and, of course, he got out of... This is a story I shouldn't spend all this time on. Anyway, he did some very good work for us there. The Navy wanted to keep him and was willing to more or less offer him anything; but he decided he wanted to become a civilian. This most naval of types who Winger thought was to become the future boss, the head of the organization. He finally got his Ph.D. and got out. He wanted to do research in medical physics, physics of the human ear and such. He did some very good magnetic bubble work, which was very much on the line of computers. He wanted to get into this other work but he found that before anybody would listen to you, even though it was regarding the physics of the human body, you had to have an M.D. So he went and got his M.D., hung out his shingle as a dermatologist (I guess that was probably the easiest speciality) and then he went on doing research. But he was a very interesting character with a very unusual career. We have a lot of people in the Security Group who are unusual characters, but they're unusual characters with a lot of brains. E.g. Pat Billingsly, who managed to finish near the bottom of his class at the Naval Academy, getting a Ph.D. and becoming a full professor of mathematical statistics at the University of Chicago. He didn't last too long either, which maybe tells you something about the education in the 1940s and 1950s at the Naval Academy, I don't know. Somebody at the bottom there of the class could really be so bright as he was! Anyway, that's the saga and that's how I got to go to the Moore school. It wasn't really, until I got to the Moore School that I became at all interested. Then I was made liaison with the ONR, also at Scott Blois' doing. He thought we ought to have a liaison, that ONR was the future, and that we should pay more attention to them in the Electronics Division of the Bureau of Ships, who was our contractor, but they had always been somewhat of a thorn in our side because...

TAPE 2/SIDE 1

PENDERGRASS: So, I went down and established myself with Mina Rees in the mathematics research; Fred Rigby and another fellow were there (his name escapes me at the moment). Later, Joe Weyl came along, son of Herman Weyl. Later, he became the head of the mathematics division when Mina Rees left. I got some men cleared and we essentially used ONR. Howie Campaign and I convinced Captain Winger that we should get right into digital computers.

ASPRAY: Was that hard to do?

PENDERGRASS: No. The hard part came later: how to sell this to the Bureau of Ships. When Winger tried this on for size, they said, "There's a lot going on here, you don't need to go into that. Everything's being done there. That's all that mathematical stuff. That's not for you." That's more or less what Winger said. So, he had me write a letter to the Office of Naval Research outlining our plans and ideas. ONR was coordinating computer development in the Navy at that time and they were in touch with John Curtiss at the Bureau of Standards. And Sam Alexander and Ed ? They were very close to all the computer business. So, Winger had me write a letter to ONR outlining our plans, what we'd like to do, and asking them what they thought of it, our ideas. But, of course, Captain Winger insisted that this be classified as secret. So it was sent down to ONR and they didn't get much secret stuff. It was handled all very separately and somebody in the head office there, I forget the Admiral said, "Well, computers, that should go to either electronics under Manny Piore or to mathematics. We finally sent it to mathematics and Mina Rees got a hold of it. Naturally, she called me and said, "What should she do with this?" I said, "Well, answer it, I guess. I mean, what do you think of it?" She said, "Well, the more people in the business, the more there was." I don't know whether the letter said ERA, but that was certainly what we had in mind. I promptly told her this, but didn't say it in the letter. I think the letter was more on just a general plan to go ahead as if we were going to put this out for contract. What we really decided was ERA. She said, "Fine, write me an answer." So, I wrote an answer saying that this was a great idea and that ONR had thought that this was a reasonable approach. I didn't say that ONR was ? or wanted to participate in anything. Mina Rees put her initials on it and sent it up to the front office and had it signed by the head of ONR, ? Joe Winger had I've never ? Joe. It was ? . I, personally, was very shy and funny. Joe Winger said this was just what he wanted to show the Bureau of Ships. But, we had to touch some more bases. He wanted to get his arsenal put together. These things just don't happen, you know. You've got to put them together

in a plan. This is what the bosses do while the underlings don't think they do anything. So, since I had mentioned the Von Neumann ideas, he said, "How about you and Campaign going up there and talking to this fellow, von Neumann?" We thought that was a fine idea, so we wrote a letter to von Neumann, which of course, was answered by Herman Goldstine. He said, "Fine, I would be happy to talk." We simply said we wanted to talk to him about computers. "Fine, I'd be happy," and we set up a time and we met up there. It snowed very heavily and I remember we were coming on the train, the Dinky, here, walking through the snow to get to the math building which was over on Washington Avenue.

ASPRAY: The old Fine Hall.

PENDERGRASS: Yes. We met. Howie had his car; so we went out to the Institute. We talked for about an hour or so with Herman and, it's funny, Herman remembered the conversation twenty years later. We talked to him, told him what we had in mind, that we wanted to go ahead, that we wanted to the Selectron. We knew it was not ready or wasn't going to be ready immediately, but we wanted to go ahead with the magnetic drum. ERA had already built a device for us with a magnetic drum. Granted, to do different purposes, but we knew they had expertise in magnetic drums. So, therefore, we wanted to go that direction rather than the mercury delay line, which was probably the number one runner at the time.

ASPRAY: This was what year?

PENDERGRASS: It was probably February of 1947. Gee, did I say 1947? It might have been 1948. We had this long prolonged fight with the... It might even have been the winter of 1947-48. I wish I could get that straight. I think it was February or maybe March of 1947. That's my best guess. I was trying to place it in connection with the 1947 conference at Harvard.

ASPRAY: It was in January of 1947.

PENDERGRASS: January of 1947?

ASPRAY: Yes.

PENDERGRASS: I am still inclined to think that it was in 1947. Anyway, Goldstine introduced us later to von Neumann. We spoke just a few words and explained what we were doing. The great von Neumann nodded his head sagely and that was about the end of the conversation. But, anyway, we extracted the promise that we could quote Herman that it was reasonable. We had one more chore. This time I went with Dick Leidler to New York to talk to IBM. We met Ross Eckert. The salesman had had our contract, was our point of contact. This was relatively low level contact, and he took us to ? This was later. Probably we'd already gotten started; but this again was just part of Winger's caution in covering all bases and perhaps covering his ass as well. This was done so he could say we'd talked with IBM. This was somewhat later, I think the contract was already been going by this time. He'd had a conversation with Mr. Watson-- either Senior or Junior, I think it was Senior, but I'm not sure. IBM had just built the SSEC. It was a terrible monstrosity in which the company found to have five percent up time. We asked if we could try some unclassified problem, which we had worked out. It was somewhat contrived because we really didn't have unclassified problems with any importance. With a little effort, Mr. Eckert would look into it. We subsequently got a letter saying that they had pleased to say that we could have so many minutes on the SSEC at \$5,000 a minute or some ungodly sum. I don't know what it was. Winger said that wasn't exactly what he had been led to believe by whichever Mr. Watson he had talked to. We just let that fizzle out. But, again, it was part of the program of touching bases, by saying that we'd looked into this and we'd looked into that. Somewhere along the line, we did get the Bureau of Ships to write task number 13 with ERA. Now, I suppose you know why the 1101 came about?

ASPRAY: Can I ask another background question? In the article that you may have seen by Tomash and Cohen of Engineering Research Associates, there is an addendum which states that you had been to visit IAS, Whirlwind, and Pennsylvania to look at their machines. Is this correct?

PENDERGRASS: Not entirely true. I never looked at Whirlwind. I had heard Forrester talk and I sat in as sort of a fly on the wall on some of his talks with Mina Rees and her great ? company. I never actually viewed the machine. We did view the Harvard Sequential Analyzer there at the conference. Of course, I had been to Moore School and had seen the ENIAC. I'd also been to the Aberdeen Proving Ground, a group that was right there.

ASPRAY: What machine was in...

PENDERGRASS: Well, that was the where they were going to build the EDVAC following on the ENIAC. I don't think that got built, but...

ASPRAY: Well, it did get built, actually. It wasn't in place until 1952 or something like that.

PENDERGRASS: Well, this was, when we went there, it was still in plans. I believe it was to use delay lines. Did it use delay lines?

ASPRAY: Yes, it did.

PENDERGRASS: So this was sort of the maneuvering. I wrote another report published in January of 1947 which was a follow on. It gave some more examples. I was writing programs in the von Neumann, Goldstine, Burks set of instructions.

ASPRAY: You had copies of their joint papers that were coming out of Princeton?

PENDERGRASS: Yes. So it was probably full of bugs and ? could be possibly written. But it was a very complicated program to show the versatility of the computer approach. Just further looking at Captain Moyer? actually. This is what you might say, because I don't think it. It did get to the Army. I mean the first paper got to the Army and this is where Sam Snyder got introduced to computers. Arnold Dumey assigned Sam to work for him to read my first paper. Sam, being assigned by his boss to read it and report on it had to read it pretty thoroughly. He said he sweat blood on it for a couple of months and thought it was the greatest thing that had ever been written. Sam has been a great friend of mine ever since. He's the one that has put my name around in his documents. But that's how that came about. In spite of what you might hear, there was rivalry between the Army and the Navy of course but we shared It was a good rivalry. In some ways competition does some good even when there is duplicated effort. They had their delay line machine, Abner, which they built, which you read about delay lines. They had a terrible experience with the Bureau of Standards. They developed a lot of ideas that were good. It was

better than Atlas in some ways but again it was down most of the time with people adding improvements. This is what happens when you build experimental machines. Atlas was built by a company that was building a machine to be used and not experimented with. I'm sure you know about Able.

ASPRAY: I'm somewhat familiar with it.

PENDERGRASS: That was built by Joe Eachus and one of Joe Eachus' guys in no time flat. It was entirely relays that had the exact same logic as Atlas. It was Joe's idea that we needed to practice a little on the programming. It was a punched tape input and old CXCO typewriter output. But, you could write a program using the same logic as Atlas. It was a great idea of Joe's. To my knowledge it was never done any place else.

ASPRAY: Doing useful work for you other than training?

PENDERGRASS: It may have. I don't know. By the time it was ready, I had been moved again and was further divorced from the business. ? had been formed and I was sent to work for somebody else, Billy Friedman, some other staff, to a staff position. Then the wagon backed up to me. I had to have field experience and I was sent out to be Officer in Charge of a radio station. So, when Atlas arrived, I wasn't even in on it. We'd already started the Atlas Two sessions, the follow-on, and I'm sure that that again was a benefit from the ABLE. It takes a long time to build a computer and you might as well start thinking about the next one. I mean that's what your R&D section is supposed to be for, I think, is to be thinking of the future. So, there were some planning sessions there. I'm sure you know far more about Atlas than I do. I was in on the early decision. Incidentally, it was Pat Billingsley, as I mentioned, who actually proved that all of the algorithms, the addition, multiplications, subtraction didn't work under every circumstance. To my knowledge, this has never been done. As a matter of fact, I've talked to ONR about it and there had never been any rigorous proofs that I could find. Somebody, George Patterson, wrote me a letter and he was looking for the same thing. He was at the University of Pennsylvania I guess. He wrote me a letter. I guess he asked ONR and they said to ask me. I think I got Pat Billingsley's proofs and sent them to George Patterson. He was very surprised that somebody buried in the bowels of the Navy Department had actually done this for him.

ASPRAY: Arnold Cohen mentioned to me that there were some specifications for doing addition and multiplication

in ways that were not consistent with the later commercial versions of the machines--that you had special requirements to meet.

PENDERGRASS: Well, one of the things we wanted to add, whether we were talking mathematically or whether we used to talk about it in vector lines adding or adding bits, bit by bit with no carry, that was specified on the first machine. That since has come up in some of the commercial machines. But at the time, we didn't see any use for it and we were worried about classification. So I think we requested ERA not to put this instruction in. That was their logical, Boolean type things which we were concerned with. Which, at the time... Don't forget. In the 1940s everybody was talking about the computer to do mathematics. All of von Neumann's chatter. I heard him lecture a couple of times. He was always solving partial differential equations concerning weather and all of these things. I never heard him say anything about logical problems. Now D.H. Lehmer had done some pure mathematics, number theory, on the ENIAC. Now that of course was known. But, it was still thought of as computing. Nobody was talking at that time in the 1940s about data entry and manipulation. Most of the computers built today don't do a hell of a lot of computing. I mean you've got to go to the supercomputer, you've got to go to the Cray, before you get into real number crunchers. But that's what people were talking about, was number crunching, in the 1940s. It turns out, of course, that the big use of computers they were talking about... IBM dragged its feet because it had no commercial application. All companies had computers now, but you have to get yourself into the frame of what the people were talking about in the 1940s. As I say, my great contribution sounds pretty puny today because that's what computers are now mostly doing handling data and computing damn little mathematics and a little arithmetic here and there. But, when they first were talked about, it was for ordnance tables. Remember the Bessel functions of Howard Aiken and all these ordnance tables that he was to churn out. That sort of thing. That was the conversation. It was only when I got to the Moore School Lectures and Mauchly showed us about programming that it became clear to me anyway that what this was was moving bits around. And somehow you made numbers out of these bits. But, really, a computer just handles, manipulates bits. We had been manipulating bits at Nebraska Avenue all during the war. That's where the light dawned. But now, of course, computers, its only the rare breed and even then they went through that same routine that the Cray... There were so few places where it could be used. Well, you're not selling them like you're selling PC's. But you never will on account of the cost of the machine. But you're selling a hell of a lot more than people were predicting, particularly in the financial news, were predicting just a few years ago. I don't know who else, whether Control Data can make it in the field, or whether NEC, or Fujitsu, or any one Japanese

company can make it. I did fool with the Cray at IDA, the Cray 1.

ASPRAY: Can I ask you some questions? Can you comment on the Navy's impression of ERA and its performance?

PENDERGRASS: [Laughter] Well, some people thought it was scandalous. There were some projects which took far too long, cost far too much. There were other projects which were done very well, very quickly. I'm sure that ERA knows all about these. They were terribly embarrassed on one. It was called Alcatraz. We used to joke that if anybody ever caught up with that one, Alcatraz would be overpopulated. It was a mechanical device, basically, which took too long for us to ?

ASPRAY: This would have been about 19...?

PENDERGRASS: Late 1940's. But, then there was Goldberg, which was a fantastic machine. The fact was that it used magnetic drums, which came before Atlas, and was new technology. It probably cost a fair amount, but for what you got there was nothing comparable available. It was during this period that IBM was most difficult as far as doing something for us. They did agree to do some work in the early 1950s. They came up with something called SLID, but I don't know much about that.

ASPRAY: It was their concern about not having competitive bidding?

PENDERGRASS: Not many people were in business in making cryptanalytic devices.

ASPRAY: So, there wasn't any opportunity to be competitive.

PENDERGRASS: Also in ERA's behalf, there were very serious security requirements. I remember Bill Norris and Howard Engstrom tripping to Washington to get us to declassify Atlas so they could start to peddle it. Captain Winger, who was the power, was very tight on security. We felt it was an ordinary computer, but he also was concerned at that time about what is our outfit doing spending millions of dollars on computers? But, we did

declassify it. I could have told him in advance, in fact I think I did tell him, that the Bureau of Ships wouldn't have anything to do with our ? The Bureau of Standards had something to do with them and they tried to sell computer standards.

ASPRAY: Why wouldn't they?

PENDERGRASS: They had their own ideas. NIH, for ? , they didn't ? it. Also magnetic drum and the criticizing and grafting on to this monkey the tubes for rapid storage and this sort of thing. But, they wouldn't...

TAPE 2/SIDE 2

PENDERGRASS: They were mixed up in some bureaucracy. Standards is an old line agency and they had their fights. John Curtiss left. Dave Cannon then, I guess, was in charge. Sam Alexander, Sam Lubkin. Lubkin was a very bright guy, but not an easy fellow to work with. He left and they got Ida Rhodes in for programming assistance. I went to some of their sessions. I tried to stay friendly with them. The Army Security Agency people got fed to the teeth with them because they got tied up in a contract with them, on building machines, and they ended up building them themselves. They were very unhappy with the Bureau of Standards. The fact that the Bureau of Standards has never done anything since, I think probably indicates that the Army was right. I don't know how much, but I think some ideas on the Univac came from the Bureau of Standards, on sorting and such. The Census Bureau was involved. Sam Lubkin's company, I think, went under fairly quickly. He left there and set up his own company to build these things, but it never got off the ground. I don't think the Institute for Advanced Study ever computed a number on their machines. For all their wonderful ideas.

ASPRAY: It got off and was going successfully for a while.

PENDERGRASS: Really?

ASPRAY: Yes, they had to change the storage, however. They put Williams tubes on. Once they got the Williams Tubes in place, they managed to get it to run quite successfully for a while. For about 3 or 4 years.

PENDERGRASS: I was out of the country during that period, but I never heard it was ever producing, or of any designs going further from it.

ASPRAY: Well, they weren't interested in doing any more computer design work, what they really wanted was a machine for doing mathematical and physical research. So there were a series of people who came through, especially physicists, to do fluid flow problems and a lot of meteorology back then. Some early AEC was done on it.

PENDERGRASS: Well, I'm glad to hear that, because by the time I left to go over seas, it certainly was not in operation. Bigelow, who was in charge, had a lot of good and original ideas. I'm not convinced, I do not know how much the ideas came from von Neumann, who was usually given the credit for the storage program. John Mauchly, I think, was certainly involved and had a lot of ideas at the same time. In view of the fact that every time I heard von Neumann talk, it was all strictly number crunching and I did hear Mauchly --I heard him more--discuss manipulation and utilizing the flexibility of the programming of computers.

ASPRAY: Turing was much more interested in using the computer as a symbol processor.

PENDERGRASS: Absolutely. But, somehow his original work didn't get too much circulation. I don't know why it wasn't picked up more. Maybe it was because the first impetus was the ordnance and ballistic tables and that sort of thing. I'm not sure that Turing himself ever really had any faith that there was any future as a big commercial enterprise in symbol manipulation. I don't know.

ASPRAY: If I can change the subject, can you give us any advice on how to go about finding records?

PENDERGRASS: There was an awful lot of word-of-mouth. There was an awful lot of unclassified documents which went to the Bureau of Ships which didn't say anything. There is one suggestion I have, if you're interested in the early days of ERA, and you'll get quite a different point of view of Eastman-Kodak and IBM's products. Has the name John Skinner come up?

ASPRAY: No, I don't believe so.

PENDERGRASS: John A. Skinner, class of 1930 of Princeton, worked for IBM prior to WWII and came into the Navy. As you know IBM had the wonderful idea, which should have been obvious to anybody, but so far as I know they were the only big company that did. They paid their people all during the war even though they were in uniform. It didn't cost them a nickel because of the excess profits loss. They charged it up to expenses. So it didn't cost them a nickel, but they had one hell of a lot of loyalty. Anyway, IBM salesmen that came into the Navy, still were selling IBM equipment because IBM salesmen had tremendous esprit de corps. It's mellowed since then and they're just ordinary human beings now. They were certainly a lot more then. John Skinner was one of these. He certainly never did anything illegal. John is very prissy and very correct. I don't think he would conceivably do that, but when your mind-set tells you that IBM is the greatest corporation in the world and they can do anything, it's very hard to be unbiased. John Skinner was in uniform and he did convert to regular Navy, but all during the war and for many years after it he was our man in the Bureau of Ships Electronic Division. He was the liaison. He was the one who dealt with the contractors. We could deal with the contractors on technical matters, but anything to do with contracts the Bureau of Ships was very jealous about. We were not the contracting authority. Needless to say, since main ERA people like John Howard, ? , Larry Steinhart, and Charlie Tompkins and Bill Norris had all been in the outfit, needless to say, they had a lot of contacts and were able to talk technically with us a lot better than people from Eastman-Kodak or IBM. We've always been sort of at arms -length. But for the early days of ERA, from the Navy's point of view, John Skinner would be your best contact.

ASPRAY: Do you know where we could reach him?

PENDERGRASS: John Skinner, John A. Skinner, lives in Bethesda, Maryland. I don't know whether I have his address or not. He just got under the wire. He was a Lieutenant Commander and put in his 30 years. I think he just made it at 62. John was class of 1930, say he was 21 in 1930 and that's 55 years ago, John is past 75, 76, 77. Last I saw him, when he came back for some reunion, 50th reunion or something, I took him downstairs and showed my Apple 2. He was all very interested.

END OF INTERVIEW