An Interview with

ARNOLD DUMEY

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Abstract

The Dumey interview begins with a description of his work for the Army Signal Corps during World War II. He discusses the development of a system for comparing data for which Eastman Kodak supplied a contrast reversal film process and Reed Research a reading device. He also considers some of the problems inherent in working for a secret organization. In the post-war period, he focuses on the contractual work done by Engineering Research Associates for the Navy, emphasizing their engineering excellence and the leverage that their competitive position gave him in his negotiations for the Navy with IBM. He highlights the roles of John L. Hill and William Norris in ERA, and contrasts the ERA 1101 with the Standards Electronic Automatic Computer (SEAC). He concludes with a discussion of the obsolescence of electrostatic tube and delay-line memory devices with the introduction of magnetic cores.

ARNOLD DUMEY INTERVIEW

DATE: 9 October 1984 INTERVIEWER: William Aspray

LOCATION: Cranbury, NJ

ASPRAY: I'd like to begin by asking you if you can tell me briefly about your own career. Especially give me background about the war time and a little on each side.

DUMEY: Okay. I'm a graduate of Columbia College and Columbia Law School. I practiced law until the war and something I did came to the attention of the signal corps. I was commissioned in it. And I went to Arlington Hall, which was then the Signal Intelligence Service, part of military intelligence.

ASPRAY: This is in Virginia, just outside of Washington.

DUMEY: I was in the Army four years and then civilianized in the same job in research and development. By this time we had set up a research and development activity, and I was head of a branch. I remained there six years and then went on to industry and became a consultant in computing because we had become very heavily involved in computers. My part of this was as a user of some of these, later in the development of some. Now let's see...does that give you enough background?

ASPRAY: Let me ask you a couple of questions. How did your law degree come into use in this work?

DUMEY: It only got me terrible assignments, in addition to my other duties, as defense counselor and law member for the military district of Washington. I really was stuck with it, you might say, as far as the Army was concerned, because I had these other duties. But I had majored in mathematics at Columbia and I had been interested in cryptography since about the age of fourteen. I had done some work in it before I came into the Army. And I was in that business. That's the kind of stuff I was doing.

ASPRAY: Is it because of that early interest in cryptography that you were placed or requested placement in the Signal Corps?

DUMEY: Oh, yes. Something we did, I can't give detail on that, but something we did came to the attention of the people at Arlington Hall and they asked another man and myself to apply for commissions. We were both commissioned first lieutenant.

ASPRAY: I understand that after the war you were associated with a company by the name of Potter Instruments?

DUMEY: Yes.

ASPRAY: Could you tell me a little about that.

DUMEY: Jack Potter worked for General Electric. And General Electric made a counter which contained ten tubes and sold for $2,500. It was all right, it ran at probably 25-50KC. Jack thought that that was no way to make or sell counters, so he developed a four-tube binary counter with a turnover at ten. In other words he arranged the feedback arrangement that cut it off at the ten. After ten you let it recycle but you then set it up as a series of counters. And he started to sell it to the government for $1,000 and became quite wealthy.

ASPRAY: About what date would this be?

DUMEY: Right after the war. As a matter of fact, we started working with Potter Instrument on a couple of things they did for us involving counting because counting is the basis of a lot of things. You can do a lot of things just by adding and subtracting. They were ambitious and wanted business; they were very hungry for business. But about 1951 or so Potter started to develop a very large memory which was based upon an array of tapes. It was a random access memory. Potter had a good opinion of me. I was rather rough on him. I didn't spend the government's money gaily. And in fact when he made me the offer that eventually resulted in my going to work for him he didn't come

himself but sent his vice president, because he thought I was mad at him. But I ended going to work on terms that I couldn't refuse and stayed with him for a little over two years by which time this memory, as an engineering matter, had started to crumble. While I was there I was called in by NSA to develop a printer for them that would take punched tape input. I designed that and also invented a method, later patented, of speeding up the time spent between carriage returns on a printer. That, together with a rather odd arrangement of printing heads, was the basis for this printing business which became much more substantial than counters, eventually. He pretty well phased out of counters because Hewlett Packard knocked him out with a faster one.

ASPRAY: Did Potter Instrument have any commercial activity?

DUMEY: Oh, yes. They sold these printers to everybody. And he always was interested in memory. I wrote a paper, which was the first paper on hash coding, based on the work I did there. I actually came there because he was hired by Time, Incorporated, on a study contract of a pretty good size to look over whether a memory of this kind for computers generally could be applied to their subscription operation. One of the very first things that happened after I left Potter was that I got picked up by Time, Inc., to continue work on the same idea. They were about my best clients for about fourteen years. They were very nice to me. I have good memories of them. Eventually all that stuff went out the window because they just went on straight tape handling and I went into the forestry end of their business. They had about two thirds of a million acres down in Texas that we were getting set for riding a herd on.

ASPRAY: May I come back now to Arlington Hall? I understand there are some things that you won't be able to talk about, but as best you can could you tell me something about the historical role of mechanical and electromechanical and electronic devices in the work of this sort?

DUMEY: Yes. I think some of it's been published because there are papers that you probably have, one written by Sam Snyder.

ASPRAY: Yes.

DUMEY: But sometimes some things are done inadvertently, that is because of the business of being secret. I'm trying to see whether I can lay my hand on it, which of course I can't do. But Vanevar Bush was called in, according to his book on his career. I don't know if you're familiar with it.

ASPRAY: *Pieces of the Action*.

DUMEY: Yes, that's it. He talked about being brought in to do something that compared streams of data. He went and he built it. It worked and they took away from him, shut the door in his face. Typical. Well, I shouldn't say typical, that was typical of me too; if you did something for me and you wanted to know what happened to it, I wouldn't tell you. But these things are all so low level compared to what was done to him. And they were "Restricted". As I said, a disappeared classification. But he designed this and about four of them were built. We had two of them and the Navy had at least one. But it also had another form of it, using the same frame and method of pulling 70 millimeter tapes, against one another in registration. It has a different name but that was much more highly classified. Strictly speaking, it might not make any difference anymore in light of later events, but I've never been debriefed on that so I won't start to mention the other thing. But on ordinary comparison we took all kinds of low-level contracts to work with this kind of stuff. These two tapes ran against one another and every time they made a complete revolution, vis-a-vis one another, one of them would index a certain number of places. There was a trigger hole to show the end of comparison. Because it was 70 mm, that would be about 3 inches I suppose, - I suppose it was 70 mm - it was possible to get as many as 40 holes across the tape. That would mean that you could set forth data in one form on that basis and the same form as another piece of tape and then look for holes. Well, when I would take generals through in some cases, I would describe how before that we used to hold the tapes up and look through the little holes at a lightbulb. And I said it would be very wearing on the eyes and we'd put our eyes in salt water next to our teeth at night to refresh them. You can pull the leg of a highly ranked officer if you know how to do it. Well, anyway, that was possibly the first, but it was also immediately evident that there were faster ways of doing the same thing.

ASPRAY: Can you give me an idea of the date on this?

DUMEY: It would be in the book.

ASPRAY: Okay, that's fine. I'll check it later.

DUMEY: So Eastman Kodak Company became a contractor for us and they built what essentially were photographic models of the same thing with the advantage (even though these were tiny holes and so on, moving that much mass of 70mm tape was a very, very difficult thing) that they were able to get within a frame several inches wide, 5,000, perhaps, elements of data because the holes themselves were 10 mm wide and about 30 high, sharply defined rectangles. They used a contrast reversal process that gave them absolute clarity where the hole was and absolute density where there was no hole. If you had juxtaposition of two holes, you got a flash of light. For summation they used a photomultiplier, which had accurate enough response. And of course then they just would count on seeing the correct amount of light because the amount of light was well-defined by the unit. Of course you'd always have a collimating sequence on it so you'd know what the number of trials was, against which you were counting hits (coincidences). Because of that, we had an interesting capability. These things worked by keeping one thing stationary and zipping the other one fast. So you actually made a hundred million comparisons a second, binary. That's a big number.

ASPRAY: That is a big number.

DUMEY: And it was not done by computers until the third generation, that's why I say some of these things.

ASPRAY: Not until the third generation?

DUMEY: I don't think there was any way you could get that many comparisons until about the third generation, oh, certainly not in the second. It just wasn't in the cards. And these things worked, they were good, because after all,

they had two things going for you. One is, your coding is what you coded in the data, that is your arrangement of data. You could do things by coding of static information. That was perfectly good for your purpose. In fact there were several forms. I just described one form. There were other forms that did the work on different bases. And they were fast. Preparation was slow relative to modern computers. Of course today at least you set your program up and you don't even have to key in data. But although keying in data in those times was not trivial, it wasn't many orders of magnitude slower than in modern times and sometimes the data was in machineable form, e.g. punched tape.

ASPRAY: Approximately what were the dates that Eastman Kodak was supplying this equipment?

DUMEY: They were doing it during the war just as Bush did. They supplied these things to us, as I said, in several versions. They supplied it to the Navy but not quite the same as ours. We had a slightly different idea about it. And they also supplied it to the other side of the water. It was used in a rather special way which again I am prevented from talking about. The great thing about this device that I described was that it would go whipping past and then it would work within the response time and accuracy of the photo multiplier about $^{+}$- 3%. And if you exceeded the threshold, then it would cut off power so it would slow down, and then it would back up at a fraction of the speed to exactly where the hit was and you got to sit and look at it. That was good with that. On the other hand, with Bush's device, all it could do was go clicking around until it had completed a circuit and then when it got to the triggering point it would print out the amount of the overlap whatever it was, and the number of coincidences that were observed, whatever you set it to do. This was a nuisance because that meant you would examine yards and yards of results on tape; that's why I'm coming to the computer end. It occurred to me that if we could compute on the fly, the expectation and the standard deviation of whatever we were looking at, we could inhibit printing except where there was an excess or too many - three sigma up or three sigma down or whatever you were looking for. I invented this thing. I described it to my people, we drew up specs and we put out for bids. Potter bid on it and I think he had already bid on it when some outfit down in Baltimore bid on it. They wanted to learn about all of our statistics at our expense. That was part of their $200,000 bid, to study up on what we were talking about. Of course, now I want to make this interesting point. We never told why we were asking for bids. We never said, "We are comparing this kind of data which may or may not come from this source or from any old source." I had to make up

an example of crackerjacks and nuts and a system whereby you had a random source that would put nuts into a box of crackerjacks and see whether you kicked the box out when these thresholds were exceeded when the box was full. That's all they knew about it, that it was some kind of crackerjack problem that the Army was working on.

ASPRAY: Now let me ask another question that comes to mind here. I am sort of surprised that these bids were put out at all. Wasn't it somewhat common for...

DUMEY: ... things to be done in house?

ASPRAY: Not to be done in house but, for anything that was secret, to negotiate privately with a company.

DUMEY: This was "Restricted", but all we had to do was get any American company really.

ASPRAY: I see.

DUMEY: And we put the problem in that form. After all, it takes a certain flight of imagination to work the crackerjack business into the kind of thing that would happen in an army corps. Well the actual bidder, he was either low or second, was a little outfit called Reed Research in Washington, owned by a fellow named Stanley Reed. They built us a big one. I think the bid was about 30 odd thousand dollars. It wasn't all that big, but it was pretty big. They came to us with a little trouble. They were going to lose a few thousand dollars so we allowed them an overrun on the condition that they'd give us a second one. So they made the second one about half the size of the first and both of them worked. And that was all. You just plugged the thing in and it would go looping around and during most loops nothing would happen (except indexing) and all of a sudden it would print. So what you were looking at was either plus n sigma or minus n sigma, all of which were settable.

ASPRAY: I see.

DUMEY: As they say in Alice in Wonderland, "that's my own invention." Well, you might be interested in how you arrive at it. How do you figure out the square root? The npq is the function we were looking for. How do you figure out the square root of n on the fly? Well you know that squares are sum of consecutive odd numbers. So we had a device that made up consecutive odd numbers that were fed into one side while coincidences were feeding into the other. So whenever it cut off, we had a counter that told us the number of odd numbers that we had added into this pot and that was the square root, by an automatic means. We had preset p and q. So it was all done just by a few counters. Counters again and ring circuits of a kind that would recycle. Well anyway that worked. That was a predecessor of the computer in a sense. Of course there weren't any computers at that time. Anything that was built of this character was like this, some of it quite complicated because things were done with applique units on IBM machines which were really extending their counting use. In fact I would say, "Isn't it wonderful that they can take these machines and put them to an accounting use?" Although in general I did not admire what IBM was still doing.

ASPRAY: Can you give me some idea of the way that the IBM machines were altered or used for your purposes?

DUMEY: Well, there are things you can do in the way of putting applique units on. Here again the notion is, if you have an IBM card (which became standard practice much later) after all, why must you consider it as a succession of codes set up by *their* instruction manual? So therefore you can code this any way you like and you can take that output and do any calculation you want. If you can set up memory, couldn't you look one card back? Then you could do things like comparisons from card to card. So some of this was done essentially by programming. That is, you would gang punch, let's say, you would use the output impulse differently. Normally in accounting practice a gang punch would be used to put one number in everything. But you could also gang punch by taking one card, doing something to it, and punch it into the following card, so you could develop a succession or some function, or recursion, or anything else you wanted using an IBM card. But I think the thing to emphasize is (a) that we were using essentially simple means and coding to accomplish whatever we wanted and (b) that all the memory we had was the medium. The film, the 70 mm tape and punch card was everything. Now, IBM was a principal supplier more to the Army than to the Navy, because the Navy already was starting to rely for this kind of equipment very heavily on ERA. Now as I said, this is the ERA started by Engstrom. Also there was Norris, who was an engineer and had

done very good things during the war times. Some of these were young fellows from the war, and some that they collected after the war and started with this group we used also. We used them for help. They were inclined to be high. As I said, the Army was very poor, we were not well funded, we printed our own money, that's why we had all this photographic equipment while the Navy just had a way with Congress, which of course dates back to the Civil War. Of course the Navy did not go over to the Confederate side en masse the way the Army did. The Navy always had better Treasury relations.

ASPRAY: Can you tell me about any of the contracts that ERA had with you?

DUMEY: Well, I remember one in particular because it had a sort of a ludicrous ending. IBM card punches we left to IBM; they worked well. One of the things we needed were punches because we used tape, and 70 mm tape. And the production of this was a slow process. We were always looking to jack this up. But the teletype punch speed was jacked up by independent development (for which they refused to take any government funding) by Teletype Corporation. The teletype punch was really a duser - the bent-knee action, the first new mechanical principle in 60 years or something like that. But for the 70 mm we went to the ERA and they produced a punch that worked and was fine except that it was a noisy thing. So we specified a glass door and they put a glass door on it, but my people wanted the door opened now and then. So we called them in and I said "I wish you could make a little latch that would hold this door open." So they put a pencil and paper in front of me and said "$500," just like that." So I said "Give me a paper clip." And I clipped the door open, and we used that for the rest of the life of it. But the reason they charged $500 was very plain, they weren't selling an item that you bought in a store. They were selling drawings, and overhead etc. $500 was a lot more reasonable for that paper clip, than some of the things that the Navy is paying for today, in my opinion. However, all the work they did was meticulous. When you get into some things that came from my close relationship to them which was after we were unified, I had a great occasion to watch it and in any situation where price wasn't a consideration (sometimes it was - even with the unification), they were the people to go to. They understood what you wanted. They were people in your background, not everybody but several of them. Engineers, by the way, could not be considered to have our background. I used to give a course in what that background would be to engineers, when I was there, and later on they could also do some of these things, but it

wasn't a great class.

TAPE 1/SIDE 2

ASPRAY: Why don't you tell me more about ERA, its founding and the people that were involved?

DUMEY: Yes, Well, two people I mentioned before were Norris and Engstrom. They were the people that ran it. They ran it as an installation in Minneapolis which was on Navy property. The place was always under the direction of a Navy captain. I'm sure also they (the captains) had some command function because the people that were used, by the Navy anyway, were either Navy or ex-Navy personnel, and particularly chief petty officers, who were a wonderful class of folks. That was the general command structure. They were paid through the Navy. In fact our contracting office which was, by this time separated from the Signal Corps, was a separate organization which did all our contracting through the Signal Corps. This caused hassles - it wasn't all that great. ERA had this group of young people some of whom were very, very smart. One I remember most for myself, Jack Hill.

ASPRAY: Jack Hill, yes. I know him.

DUMEY: When he worked for Minnesota Mining and was paid shares of stock, he made some headway by trading his lunch for shares of 3M stock. I don't know if you know that. But I think he retired on that little venture. He left ERA not long after I left this business and either went to work for somebody else or started something of his own. I guess he's not suffering. Louis Drake was one of that crowd. They were so good at business of this kind that if I had a thought then suddenly there be a flash of lightning and there would be their rep. standing in the doorway. And who the heck was this guy? I forget who he was. They were all so very, very good, for me anyway, as a method of keeping IBM in line. I had 15 contracts with IBM and IBM was always giving you policy. I have my own policy, I don't believe in anybody else's policy. I used to have a pad made out of gunk that one of my contractor's made me, some kind of damping material, which I kept on the desk so I could bang my hand down and say, "There ain't no reason for this; it's our policy!" without damaging my bones. IBM would always pull this kind of thing, and I

discovered very early that I could bring them right to heel. I'd say, "I want something." They'd say, "We can't do this or we can't do that." I'd say, "All right, I'll go to ERA." And there would be a flash of lightning and the fellow would say, "Oh, I just got word, our policy has been changed. We can do it." He would do it on the fly. Lose the sale and lose the job was the IBM rule and if they could push you, they'd push you. But it helped to have this second source particularly as it was a very, very good source. As I said, the engineering was terrific. There was one instance which involved actually doing a certain thing (I happened to have cooked this thing up so I look at it with pride and I think whatever reputation I have is in part due to this particular thing) and of having an equipment of ten thousand tubes ready in thirty days. I called in Jack Hill and I told him what was involved, in half an hour. They went out and they had it plugged in and running at the end of the month. Now it was cost plus, so all hands were put to work on it as high priority. But it was ready in time. And it was a tremendous kudos of course. For years after that, I'd be in some airport and somebody would come up to me and say I worked on some equipment and then they'd give me the name of that equipment which they remembered. But they were capable of doing it and not everybody could pull some stunt off like that. When they built anything, as in the case of the 1101, or any such computer, since it wasn't going to be used on their premises, they got it to the point where it ran, then they took it down and put it together again and saw if it ran. And they fixed that. Then they took it down and took it to your place. By that time they'd been through at least one exercise of this kind, and my weak recollection is that the 1101 was up and running in three days. The same was true of the 1103, which was the Atlas 2.

ASPRAY: That's right.

DUMEY: Atlas was a character in a cartoon... Well, the point is that in the Greek classical mythology Atlas held the world on his shoulders, fine. But in the cartoon "Barnaby" by Crockett Johnson, there was a very, very smart mental giant called Atlas. And the Navy named a lot of its equipment after these characters from Crockett Johnson. So Atlas was the mental giant and Atlas 1 was the name for the 1101 and the reason it's 1101 is because...

ASPRAY: Project 13 in binary.

DUMEY: Right. After that, I think everybody forgot so the 1103 is not binary. The 1102 was never actually built, not a computer.

ASPRAY: Can I come back? The Navy was quite anxious to have ERA succeed. Can you talk about the reasons for that?

DUMEY: Well, after all, this was a force in being. The idea of doing things in house was great and nearly right. We were much better off developing our own capability on many things. But you were always under fire from that part of Congress which wanted to have things done by outside contract. (Therefore, to have something for which we were responsible essentially succeed was extraordinarily important.) These weren't...just old school ties because these weren't regular Navy. If the ERA had been founded by an ex-admiral, you know, or some other ring twister then you'd say well it's just old school tie. It wasn't that at all, because these people were civilians.

ASPRAY: In an article that Erv Tomash and Arnie Cohen wrote it is suggested that after the war the Navy wasn't able to retain the kind of personnel that they'd had during the war.

DUMEY: That's true of all the think tanks. The think tanks have a different salary structure. The think tanks were able to get people. They were able to because of two things. You will find this true of Rand; this is true of IDA which had been the Weapons Systems Evaluation Group. First, you had all kinds of ceilings which they were able to disregard for a while. So they were able to pay competitively with industry. The government cannot do that. You need the smartest guy in the world, you can't get him from Congress, never. And that was one item. The second thing is that special rules, in house rules, that govern personnel do not apply there. During the war we were up to our ears in Ph.D.s who were enlisted men. But they were going out and doing KP because even if they were sergeants, they weren't sergeants of the line. So a non com doesn't do KP, I don't know if you are aware of this. (A non-com who was not of the line can.) So they made them do KP, pulling them away from the work for which we had them there. So you had a Ph.D. peeling potatoes or going out on drill. The same thing was true on the Navy side. You have military duties that impinge on what you might do. Then if you're a civilian, there are two things. One is

pretty well borderline. The fact that the line officers did not look kindly upon something that was a sort of a privilege, civilian freedom. But as time went on, that prejudice went out because civilians were just too valuable a resource. Keep the people you have in the house happy. And secondly, civil service regulations themselves imposed many restrictions on people which in a think tank are not there - there's a much more relaxed atmosphere, freedom from many kinds of useless reports and evaluations that weren't very meaningful. So there were a lot of these reasons for the think tanks. We have about six or seven of that size and their main attraction was the above. What had happened in the last few years, is that the government has reached a pay scale where in many cases it exceeds what a think tank can pay. This means that think tanks now sort of bleed off into industry where they might not otherwise. A properly run one still is more fruitful in that respect.

ASPRAY: Let me ask another question that comes up in the Tomash/Cohen article. They claim that the need for the kind of work that had been done for the Navy by these people was greater at the end of the war than it had been during the war. Or was greater in peacetime than wartime, they claim.

DUMEY: I wouldn't say that - that's a little precious. But I think the theory was, it was a new ball game. See after all, of all the problems that were worked on during the war, the principal ones had been worked on before the war. So they knew about where they stood when they started out. Then we had all the targets wiped out, and no longer had an Enigma problem to look at. There was no longer any Germany to do it to. They no longer had the Geheimschreiber. They no longer had the JN 25 or the Purple. Certainly the value of those things in anything that was developed to make cryptanalysis work better was incalculable. But the target was at the end of it. It's different from any other kind of science. People will still turn out papers on the common cold after we finally get the thing licked. There will still be the spate of whatever is left telling about the experience with ipecac in some obscure African village. That isn't true when the Enigma problem disappears. Remember that 95% of the money you are given is to keep your mouth shut so you just go away and do something else. So they had a new set of targets and no tradition. They even had new countries. If I have to justify that statement I would say that I think that we did have a feeling of which way we were going to jump, what's worth doing and so on. I remember that. I also remember that I think we made attempts to try to guess. Well, a guess is not worth a damn. Because along comes some bright

guy who has an idea for some system or method and so on and everything we've learned before is no good, which is really why the general purpose computer keeps you going if you do have something to think about.

ASPRAY: OK. Let me turn to a slightly different set of questions about ERA: Personalities and strengths of various people. It seems to me today that there's an awful lot of credit given to William Norris for ERA, but there were a number of people involved in the company in the early days.

DUMEY: I hardly remember now. I remember Engstrom, and I remember Tomash and Shackel. I remember Hill.

ASPRAY: Meader?

DUMEY: Meader was a captain in the Navy. He was in charge of the installation, he was not...

ASPRAY: He became a founder..

DUMEY: That's right, he was a founder. But he was captain in the Navy I never thought of as that strong. The people I thought were strong were the young people to whom you could explain things and they would come to immediate understanding. I remember now, Meader? I was wrong; I'm thinking of some other guy. Svenson, was that the name ?

ASPRAY: I think so.

DUMEY: There were at least two that I remember on the staff who had what you might call troop responsibility and handled the place as a Navy installation. Norris did very good work during the war according to what I've heard.

ASPRAY: He was a CSAW personnel.

DUMEY: He was a lieutenant commander I think. Engstrom was a captain and was commissioned in the service and was really a very, very bright guy. But if I had to deal with somebody, I dealt with the engineers rather than the management. I was only too eager; they wanted to do it, they drooled. What the heck. If you could cook something up that would use the whole plant for a month that was great. And I came through. They weren't always imaginative although we had been well established, 1101 had been delivered. You know the 1101 had a real time clock.

ASPRAY: Yes.

DUMEY: And that meant that when the 1101 came in, it was ready to go. The 1101 is a remarkable machine against anything you want to say about computers, because of the amount of lying that has gone on about the capabilities that computers have; it's simply fantastic. Remember the SSEC?

ASPRAY: Yes.

DUMEY: IBM had pictures taken of SSEC. It was this tremendous device with all these clocks and dials. And we went down to call - to take a look at it because Steve Dunwell, who is a very nice guy and an old Arlington Hall officer, was down in New York. So, a group of us went to call on him and he was out and now comes an all American boy. He was very nice he took us and showed us the backstage stuff but nothing was moving and I said, "Nothing is moving." Well, those people over there, they're all huddled around, "They're working on a problem for a customer." So we were all through. I gave this All-American boy a piercing glance, and I said, "Now, what's your up time?" He said "You mean the down time." I said, "What is your up time?" So he looks back at me and he says, "50%." Now that's the first time anyone used a number as low as 50% and I thought, "Isn't it nice to find an honest man?"

ASPRAY: I see.

DUMEY: So anyway they had a machine that worked 50% of the time. However, at the 25th anniversary of the

Association of Computing Machinery we had a shindig out at Washington and there's a picture I would like to have of all the people in it since '46. That was '71. And Herman Goldstine, who originally worked on the ENIAC, gave a wonderful talk on the early days of computers, including the SSEC. The mean time between failures of SSEC was about a minute - max. It *never* was up. The reason they were standing around there was that they were composing a program that could be run in an expected time of ten seconds, because they couldn't be sure that they'd be running on the eleventh. And here I'm taken in by this guy who looks at me with this honest face who gives me a number lower than I have been used to hearing. That's background. That's the way most computers worked. On the other hand, the 1101 ran 22 hours every day and was then taken down and routined. They did margin on all tubes and any chassis that didn't come up to margin was pulled. It ran for 22 hours, seven days a week. And that was the general operation for years. It went out of operation once when the air conditioning failed and they burned up the whole goddamned thing. But that's the way this thing worked. That's the way it was engineered in a time when you couldn't get ten good seconds on the SSEC - when the MTBF was "big talk". Here was something we put problems on. There were problems that were run on that machine that used to run 22 hours. You used to sort of record where you were and run for 22 more. So they put in one input for tremendous number crunchers that used all of the total memory. I guess there was one program that they ran for years and years and years and we had no problem with it. No question, it was a valuable program written by a great programmer so that there was no memory left over. The whole thing was spoken for and it ran and ran and ran, for 22 hours a day. That's a machine that was installed in three days. You'd have wrenches all over the floor at the average installation while they were putting a computer in and oscilloscopes everywhere for weeks and months. It wasn't nearly that easy to put up the SEAC counterpart we had. The 1103 was put up no less quickly. And that took up a whole bloody room. Now, I wanted to tell you something about the work they did before they delivered. They weren't the only contractor. Once there was unification, there was a lot of pressure not to have a sole source.

ASPRAY: Unification, for our purposes of the tape, meaning what?

DUMEY: The joinder of ASA (the Army Security Agency) with CSAW into one cryptologic agency with spinoffs for the Air Force, for troops and supplies and certain other functions. So we ended up with four things where we had

had two. But I think unification was great. I got to know a lot of people, who were very friendly, with whom it was a pleasure to work and from whom I learned a lot also. Also, those of us who needed money got more money. We didn't get more pay until Canine came with the ball game. The ERA was still a principal source after unification. You must realize, and maybe this was the thrust of what Tomash and Cohen are writing about, that before there were computers there were similar problems. And if you had an insight into how to go about solving a problem, you were vastly better off doing it by a special device. This is true today, that the whole notion of distributed computing, even, if you wish, machines that CDC made and CRAY made of having these little blisters around that did special functions, was based upon that. If you have something dedicated to something, then you can do such things as efficient memory usage and shorter paths for setup and various concepts that are taken care of much better than you can than by going through the thing linearly, and this will continue even after they have their associative memory, I suspect. So whatever they could do, for example of the kind that I mentioned - above it was something that in that particular case I don't think that the third - there was a third generation of computer - and maybe not a fourth that could do that specific job. The only way to do it faster is to build a copy of it with a little faster input. Except for that, the computer doesn't stand a chance. What one had was essentially a kind of an associative memory which they're not really good at yet. As far as distributed functions are concerned, I ran the first workshop on distributed computing back in 1970 in Atlantic City at one of the conventions. It went over like a lead balloon - we had just enough people to make a workshop - we wrote a report, that was printed and that was the end of it. Webster used to have a cartoon "Born Twenty Years Too Soon." Ten years later if you didn't talk distributed functions or something like that, you weren't in the computer business. You might think of some of the stuff that we were doing through ERA and through IBM as distributed functions. Such things as the work we had done for us on memory. We were working on faster drums and tighter packing. The worst of that was, it wasn't a very cute idea. You do it and five years later its absolutely old hat, because in the computer game the worst - I say worse rather than better, it depends, of course, on how you think about it - is that as far as hardware's concerned - the development of hardware is always ahead by a considerable factor than your expectation of what it ought to be. Large scale integration is way ahead of where anybody would have said. But programming is where it was in 1950, in spite of all the papers written by all the Japanese and everybody but Americans in these Transactions of the Computer Group, IEEE, it's all talk. All this is just yak because they're not advancing. They're saying five years from now, five years from now and they don't

produce. While the hardware people are producing like crazy with memory, with circuits, with everything.

ASPRAY: Before we were on tape today, you mentioned the National Bureau of Standards and your relationship with them at Arlington. Could you tell me about that on tape?

DUMEY: Yes. The National Bureau of Standards was developing two computers; one, SWAC, Standard's Western Automatic Computer which used a memory of the Williams tube type and the Eastern Computer which used the sonic-delay line. The sonic-delay line had much better capacity than the tube, but the tube was closely spaced with micro-second pulses. So, essentially, based on different principles, the access was different in each computer. Your access to any particular point in the Williams tube was one pulse time. You set up your two co-ordinates and you were there. In the SEAC, you were dealing serially, so if you had something to do, you had to wait while the place to do it came around. Therefore, just as in the case of drums, a whole technique developed of minimum access coding, which was applied to it, which was applied to the drum in the...1101.

TAPE 2/SIDE 1

DUMEY: Actually, as I said, we developed for the 1101 (which brings you into the ERA) programming techniques that took account of the fact that you might have to wait a long time. But, I might just say, that there is a second aspect of it which obtained in computing until a very late date, until core was so far in that minimum access was a sort of passe notion. And that is the fact that different functions took different lengths of time. That is why I wanted you to have, if I could have found it, the 1101, or Atlas command code because it showed you what the waiting time was. In other words, they would say if you so and so, this switch opens, that switch opens then "wait arithmetic". Because the next thing, you just sat around and waited for an operation to be done which would vary, not only according to what the operation was, but I suppose even the multiplication varied according to the number of ones in the word. You see?

ASPRAY: I see.

DUMEY: That meant that there was a real art, which I said we developed... Now, we couldn't develop such an art in the 1101 because there was, at that time, no automatic coding to calculate expected time for you. You wrote your thing on a little octal tape, three hole punch. I would maintain I used to bite my program in. And then you'd see this thing and so you'd write out a whole set of these octal numbers and a skillful programmer would do it very well and there were such, I might add. The reason why these things ran is because they were maintained by people who watched every little flicker. They hung around. We were well manned with Navy personnel, and if you came down with a program, then they'd bet you a quarter that it wouldn't work. So, I was just sort of a big cheese around this thing, I knew what was going on, but Joe Eachus said, "You have to write a program." So, I wrote a program, it was a program of counts, it would do counts. Actually, some lines of Virgil's Aeneid were my input. And I went down there, put a quarter down, and put it in and it ran. But, that wasn't true in general of programs. Most programs didn't run the first time. It wasn't until, I guess, SOAP, the IBM program for its 650 that anybody actually automated the notion of how you should pick up the next address. An operation takes this long so you can figure out the next place you look, for the next address.

ASPRAY: What was the relationship between Arlington Hall and NBS?

DUMEY: Well, we were Arlington Hall and so we made this contract while we were still the Army Security Agency, which had been founded immediately after the closing of the war. We had various names; we were called the Signals Security Agency, the Signals Security Service, the Signal Intelligence Service. In fact, although this is old hat now, when you went in, you took 89 oaths on a whole stack of Bibles in every language. One of the oaths I took was never to mention Signal Security Agency or Signal Intelligence Service, or Signal Security Service or their initials to anybody not in them. I was very friendly with Col. Kullbach and once I went over to his house and his brother-in-law was there, a civilian, a lawyer. Suddenly, Kully pops out with one of those names. Well, I almost fell off my chair! It happened that the brother-in-law went back somewhere else in the house, and I said Kully, "You know what you just said? You just said Signal Intelligence Service." He says, "Why not? It's on the stationery." So it was not such a breach as I had thought, as I found out. But, those were the names used because we were actually under G2

operations, although we were actually Signal Corps for troop matters, discipline, things of that sort. And after the war, we became a separate service, a part of the military intelligence community which was called the Army Security Agency. And it had, at first, a colonel in charge. Later on they brought in a commanding general and we made contracts with the Signal Corps handling the paperwork and funding. Because, you look at a chart of the Defense Department or 62, you see the Army Security Agency and there are no lines from it. Who commanded it, you know? And if you asked a fellow well, where are the lines on it? He'd smirk. That's because it's hot stuff to smirk at that time. Well, we knew that they were building SEAC, we went to them and as I said, their plan was not to build it for us, we built it in-house. But we used their first plans and as it was in those days, you know you had walls covered with logical diagrams. We had one or two commanders that were better suited to our purpose, but the logic and all, the coding, the encoding of characters, the way a word was set up, all that was set up by them and was character-oriented like the UNIVAC as opposed to bit orientation. In other words, the word was the unit, which was the ERA 1101 way of looking at it. I didn't take sides on this matter, and I felt very simple, but there were some very hard feelings about which was the "right" way to do it. I think it unbalanced the word concept. It went out in spite of the bytes. And boy, bytes have a terrific advantage. Anyway, we just kept getting reports, you know. Occasionally, I'd get down and see how they're doing and stuff like that. They tried to suck us into automatic translation, and Kully and I were down with at least one fellow who worked for me, a very good programmer named May. And there was John Curtis, making the big pitch, I think Sam Alexander was probably there. Also, there was Berkeley, Ed Berkeley. He was doing some work, I thought for Prudential. And there was a guy from AC Nielson. They were looking for general support, but the thing they were going after us for, was this business of doing translation. On that they got a short answer: "No." I said, "It won't work." Finally Curtis says to me, "Well, wait a minute", he says, "Just think, you'll be able at least to recognize and handle Russian technical articles." "No sweat," I said, "all their technical words come from German or French, it's no big deal." And Bill May, who had a wry wit said, "Isn't it funny? The Russians invented everything, but not the names for them." We never put any more money into this which is, of course, the first time the government has ever saved any dough.

ASPRAY: Did you provide any specifications or other requests that had some bearing on the other machines that were being built at Standards?

DUMEY: I don't think anything we did, although Bill May was closer to setting up programs, he worked for me and Sam Snyder. But, I don't think anything we did made them change anything they were going to do. But, we did give them things that we wanted capability for on our side and that did give them something from us. They had a pretty good notion of what they wanted to do and they had a machine for it. Of course, the Bureau of Standards strictly speaking, was not in the computer business. Their idea was standards, and if they do anything of this kind, it's to help them in standards or to develop some sort of standards for records for their archives. You haven't seen Joe Eachus; you ought to. You ought to see Jim Pendergrass if he's in town. It is true that he might not be. He goes away for long weekends at a place he has in Pennsylvania. But he's the one in the Navy and Eynon Roland was the name of our man over at the Moore School. But Eynon was not what anybody called him; it was something else. He had some other name; Tom, I think we called him. It sounds reasonable. And he and Pendergrass went to the Moore school and brought back these reports, which you probably have in your museum. But, Jim Pendergrass wrote a paper that made a case for the Navy support of a project like this. And it sold. I doubt whether you can get that paper; it probably has stuff that is still classified. But, he's the one that started it off. Joe Eachus had to be sold, but he was sold. He was a staunch supporter of these ideas. That was as far as the 1101 was concerned. When the 1103 was about to be started, you were viewing the two kinds of address systems, the SEAC was a four-address system. It had an order, two operands and next order, which it had to have because of its characteristic of not knowing where to look. The 1101 was a one order system. It just gave you the place where you looked next and it was your programming that told you whether you were going to get anything else because it was just counted out. In other words, they had the command word which was ten bits or something like that. But these were interpretable, so actually, you had a counter that said what was the next thing you look at because the locations were coded on one side of the drum. You could also plug these so that the number would work differently, so, actually, you were changing the scale of looking. That was one thing you could do. So, if you had something that was intrinsically all multiplication, ... you could allow time for multiplication steps in between things. But, otherwise, you might simply have to pause and wait or do something to throw things away or very often be very, very clever. But, there wasn't any provision in there for actually setting up a jump or anything of this kind. Neither was there a B box [base register for addressing]. And, in the case of the 1103, you had a different situation because you had a two address system.

Let me look, am I correct?

ASPRAY: Yes, that's right.

DUMEY: In fact one of the SEAC supporters who worked for me was very irate about this. He said, "The Navy's had a one address, now they have a two address, next they will have a three address." I didn't listen to them. We taught people what the hell? What difference? But, as far as the command code was concerned, by this time they had experience, you see. So, they could see how they made out and find out what things they wanted new or better done this way. They were going from the time access of the 1101 into the random access of the Williams tube. The Williams tube, of course, was still hot stuff until late in 1953 when Papian ran his shower stall at MIT for one trillion operations. So, first of all, if you were going to go anywhere, it became important to know what the next address was. After that, of course, you could do anything you wanted. And what to do under those circumstances was largely determined by a sort of in-house group that was recalled because the Korean War was on. They recalled to active duty a whole bunch of Navy mathematicians, including Andy Gleason, who kicked like a steer. He said... he would kick and kick and finally somebody said to him, "Boy, you, you went to drill, didn't you?" He said, "Yes." "And they paid you for the drill, right?" "But, I wouldn't have gotten this length of time if I had stolen the money!" So, anyway, at any rate, they kept it a pretty closed thing, but I didn't mind. They were very good men. They were a superior group and they concocted the command code that you have in that particular piece of paper right there. And the ERA set out, built it, and it worked. It was a hairy thing because the tube was never a great memory device. There was always the problem of refreshing, or else having a very hairy electronic to keep it without refreshing, spraying or anything like that. And at MIT, which was a great believer in this, they used it in Whirlwind, they had a laboratory that was a two million dollar investment for Forrester's tubes. But, it used 200 fresh pairs of nylon gloves per day in a clean room. Dudley Buck worked for me, and then left the Navy (he was an ensign in the regular Navy) went up to MIT to get a Ph.D. and be on the faculty. So, he worked around Whirlwind and one day when I was at Potter he called me up and said, "Papian was going to build a core memory." We were going crazy, we had this contract from NSA to build this printer and the memory problems on a printer that runs from a drum are terrible! Really terrible. We scrapped everything and we built the thing immediately with core and we delivered the thing on time, and that was

probably the first commercial device using a core memory. It ran for years and years. It worked. But, core memory wiped everything out. The day I went to MIT to see it, this core memory had only been running... was only a day or two old. I went into this laboratory, which I had visited once before while it was in operation and was now a deserted village, all these white nylon gloves lying on the floor everybody'd gotten out of. And from then on, of course, tube memory was all just an obsolete art.

END OF INTERVIEW