

An Interview with
CHARLES M. HERZFELD

OH 208

Conducted by Arthur L. Norberg

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Abstract

After a brief discussion of his professional career at the Naval Research Laboratory and the National Bureau of Standards, the interview turns to programs in and administration of the Defense Advanced Research Projects Agency (DARPA). Herzfeld describes his tasks as program director of the Defender program and his interactions with different management levels at the Department of Defense. The major portion of the interview is a discussion of his knowledge of the Information Processing Techniques Office (IPTO) program and his interaction with IPTO personnel.

CHARLES M. HERZFELD INTERVIEW

DATE: 6 August 1990

INTERVIEWER: Arthur L. Norberg

LOCATION: Washington, D.C.

NORBERG: Can you clarify for me what the various jobs were that you held in the 1950s? Which was the primary job, NRL or the University of Maryland?

HERZFELD: Maryland was a part-time job always, and NRL and the Bureau of Standards were full-time jobs. The truth of the matter is that when I first went to NRL I found that the University of Maryland had an evening graduate program in the physics department. There were a number of federal laboratories where there were some off-campus operations; NRL was one. I started teaching at NRL, and then I became an adjunct something or other. When I went to the Bureau - I went to the Bureau because I wanted to be at the Bureau - I found that the same University of Maryland operation was going on at the Bureau of Standards, but it was the biggest of all the off-campus things. And I started teaching in that. Soon after I became division chief for the Bureau of Standards they gave me that to run. That's when I became a full professor, adjunct, part-time; a full professor of physics at Maryland.

NORBERG: I see. What sorts of things were you doing as assistant director at the Bureau of Standards.

HERZFELD: Associate director?

NORBERG: Yes.

HERZFELD: I was associate director only for a few months. I was chief of the heat division from... (well, you have the dates)... until early in 1961. And I was then appointed the associate director for planning for the Bureau of Standards, which was a job that was prior held by Nick Golovin, who was then a well-known fellow in Washington science management circles. Nick left to do something else and they picked me to do that. It was a curious state of affairs. At about the same time Jack Ruina asked me to come to ARPA (as it was known then) to take on the

Defender program, and I turned it down. I had just gotten this really fascinating job at the Bureau of Standards and I wanted to do that for a while. During the summer I went on a trip to visit about five or six European Standards Labs to meet the people and actually brought some exchange platinum thermometers. We usually would circulate instruments so everybody used the same ones so that there's a correlation between your thermometer and mine, and you would exchange the same measurements on each other's instruments. While I was in Paris, I guess, the Berlin Wall went up, and things really started to get very, very dangerous looking. And I thought, well, I guess I am more needed at the Defense Department, and when I got back to the States I called up Jack Ruina to see whether the offer was still open and he said, "Yes." And so I left the Bureau of Standards under rather strange circumstances, because the Bureau couldn't really understand why I was leaving such a top position at all.

NORBERG: Had you known Ruina before this first contact?

HERZFELD: No. I had known him by reputation, but that was it.

NORBERG: I see. Do you remember how long a time elapsed between when he telephoned you and when you came back from Germany?

HERZFELD: Yes, approximately. I think he must have contacted me in May of 1961, and then I got back around Labor Day, and I was working here down the hall in September.

NORBERG: How much of the Defender program can you talk about and how much of it is classified?

HERZFELD: Oh, there have been endless open hearings about it, so there is a great deal of literature about it. And I can talk about virtually all of it.

NORBERG: Okay, can you tell me what you were first asked to do when you came?

HERZFELD: Straighten it out.

NORBERG: [laugh] Was everything that way in ARPA at the time?

HERZFELD: No, but DARPA had a very rapid growth with very little staff of their own, then a rapid reduction as most of space programs were moved out. Still very large; it was on the order of a quarter of a billion in 1961 year dollars - a lot of money. It had grown somewhat like Topsy, and had all of the expected problems - a certain lack of coherence, some duplication, some of the right hand not knowing what the left hand was doing, lack of a strategic direction in the different offices. And so Ruina, at the behest of Harold Brown, who was DDR&E then, decided to fix it. They tried to get the best office director as they could. They did rather well; it was a rather stellar bunch.

NORBERG: Who else was there at the same time you were in September?

HERZFELD: Well, Bob Frosch joined soon after I got there to take over the Nuclear Test Detection office. And one of our problem projects, AGILE, was getting a new director - I forget who that was. I didn't have that much to do with AGILE at that time. My recollection is that Licklider at least began to appear a lot. It may have been somebody else who officially had the chair of office director. I seem to remember that Lick gave a series of introductory lectures to modern computing soon after I arrived. I have always told people that the story of my introduction to computing was a very auspicious one: a series of three days' worth of seminars by John von Neumann at the University of Chicago in 1948 or thereabouts, better than which it was hard to do. And that just changed my thinking about almost everything. That was good enough for fifteen years or so - whatever it is - until I heard Lick's talks in this building in 1961, or conceivably early 1962. And that in turn was good enough for quite a while.

NORBERG: Why do these talks by Lick stand out in your mind?

HERZFELD: They predicted the future of computing in America remarkably well, number one. I mean, they said, "We clearly can do the following. It makes sense and we ought to do it, so let's go do it." And indeed, it happened.

Networking, interactive graphics, time-sharing, and all these things that are now commonplace were in the air, and he saw to it that they would happen.

NORBERG: I guess what I am trying to separate out is what you remember now and what might have occurred at the time to see whether or not there are any specific details there that we might focus on.

HERZFELD: Hard to say, but it was clear that... You know, I had had some interaction with computers both at Aberdeen and at the Bureau of Standards, and they were totally of the old-fashioned variety. I would state my problem; I would go to a programmer who also was somewhat of a mathematician, since my problems were mostly straightforward mathematical problems that were not solvable easily in analytic form, but were solvable. Then this individual would go off and program something and run it, and give me a stack of paper. I would go through the stack of paper, and it wasn't quite what I needed. So I went back to my programmer, and so on. It was very much the classical way things were done in the 1950s, and much of the 1960s, in fact. And Lick kind of explained that one could do significantly better than that. And indeed, we are doing it enormously better. I mean, I am reasonably PC fluent. In fact, I have a fairly good machine at home on which I do basically toy problems; I don't do anything very serious. But learned enough that when I visited Thinking Machines not long ago they sat me down in front of their Connection machine demo programs, and within a few minutes I was able to run the Connection machine. In real time, just hacking away at the demos that I wanted to do, in a limited set and all that. I knew what needed to be done and how to do it. I was having fun with it and I could play with it. But that's just an incredible change in 30 years or less - 25. And it's possible to keep up with it. It isn't like it's an incomprehensible subject; it's perfectly doable. Of course, that was Lick's point, that computing should be natural, not unnatural.

NORBERG: Let me ask an incidental question here just to make sure that we are both telling each other the same thing. How much contact did you have with Lick after you left the Department of Defense in 1966?

HERZFELD: Very little. I left in 1967.

NORBERG: Sorry, 1967.

HERZFELD: Very little, except occasionally there were some DARPA meetings, or I met him at some MIT meetings and so on; but very little.

NORBERG: Okay, now, back to the lectures. Were the lectures given in any context of particular kinds of problems to be solved that you remember?

HERZFELD: Yes, I would say to make computing accessible, to make it more efficient, to really use the power of the computers that were available, which he contended - and I believe he was quite right - were used in a very inefficient manner. The idea of networking many computers, the ideal that you would not know on which computer your problem was being solved, nor in which computer's databank did the data reside that you needed for solving your problem, that the whole system became transparent and you just did what you wanted to do and all the rest was taken care of by the system.

NORBERG: Do you remember any discussion of military problems?

HERZFELD: Oh, yes. Command and control problems principally. The emphasis was not as much on design problems, though we did, for example, in the... There was an MIT program to do ship design with interactive graphics to deduce from the new shape what the drag would be and the weight and all that, automatically. So that by just changing the drawing you could, within minutes or seconds, depending on the severity of the change, see what the impact of the change was, and decide whether you liked it or not in terms of ship characteristics. Now, we talked then about turning it around and finding optimizing algorithms for giving the computer the ship characteristics and letting it figure out the shape, but that was clearly off in the future.

NORBERG: Were you then having contact with the people at MIT who were doing this?

HERZFELD: Well, in the first two years, no, or very little, except that they were contractors for Defender also and we were contributing some of the computing problems. Defender was an interesting place to be sitting, because while we were doing our ABM work we were creating instruments, radars in particular, that were taking data out of the air, literally, at an unprecedented data rate. And so we were also funding development of magnetic recorders that were very, very hi-fi at 10 or 20 megahertz bandwidths, which are commonplace now but they were very high rate then. That was in the very high rate category.

NORBERG: Who was the contract with?

HERZFELD: Oh, Honeywell comes to mind. There were several. And in turn we wanted to get these data analyzed in as real time as possible, which drove us to the latest computing techniques. And we wanted to have the radar in KWAJALEIN and the computer at Lincoln Lab...

NORBERG: Yes.

HERZFELD: ... so to say. And so we got into high-speed data transmission issues. Satellites were thought of, but not available at that time. And so we were in many ways the customer, a customer of the most high-powered applications.

NORBERG: Okay, I'll come back to that in a minute, if you don't mind. Let's continue with the Defender program. Can you describe for me, sort of, let me say, office routine in that early period, 1961, 1962, 1963.

HERZFELD: Do you mean office routine?

NORBERG: Yes, what went on? Who did you deal with on a daily basis? How did proposals come in? Were specifications developed in the office? What was the contracting procedure, and so on?

HERZFELD: From my point of view, it was made very clear to me that I was responsible to Ruina and Harold Brown and McNamara to put the program into a shape that made sense in several ways: sense in terms of a good technical program, and in the sense that you were supposed to figure out what kinds of ABM systems would make sense from a defense point of view, a national security point of view. Nearly as soon as I arrived, within a week, McNamara assigned to the Defender program the task of monitoring the penetration aids programs of the Air Force and the Navy to get through Soviet defenses, and to establish a kind of a net technical assessment of how we would do against their defenses, as well as they against our defenses. And I really had very much the direct responsibility for that. So I had found a number of things, of course. I found a lot of programs, and it took a year or so to really make a big change.

One thing that stands out was there was a large number of helper organizations that had been hired to help design, run and evaluate programs. A lot of money went into that, and we were under constant pressure to explain what were we doing with all these helper organizations. So we finally put together a sort of master plan about who does what, and who is good for what, at what, and so on. We had all that worked out. Then there was a kind of built-in natural, but I think very appropriate, tension between the people who were thinking in terms of systems, people who were thinking in terms of the technology and science, and people who were thinking about the military utility. And that's when I first met Herman Kahn and Tom Shelling and Henry Kissinger, because I asked them for help. I wrote them letters saying, "Here I am. I am running this beast; I need to understand what it means. Can you help?" And so I wound up helping Herman Kahn found the Hudson Institute, because he was just then looking for money. We were one of the first to fund him significantly. And I wound up in Shelling's long-range, ten-year strategy forecast that Walt Rostow had asked him to do. Who was the chief of planning in the State Department? It will come to me. Anyhow, I got to know Kissinger, and have known him ever since, and worked with him, consulted for him in the 1970s.

So a lot of things got started in 1961, 1962. On that front, because I wanted to know what made sense and what didn't, that very quickly pushed us into the arms control and strategy debates, and I have never left that arena, I guess. And one tier down, we wanted to integrate all of the things we could see from a technology point of view as

being possible in various kinds of systems concepts that would make technical sense, and then also would make some military sense. So we had a fair amount of work going on in systems, which was mostly paperwork, but occasionally in some very major demonstrations when we wanted to see if some things were feasible or not on principle. And some were, and some were not. Lots of old concepts that got started in the 1950s were still hanging around and money was being spent on them. We kind of devised a technique for making them prove their worth and if they couldn't do that, kill them. We killed a whole bunch of things, like throwing out lots of debris which didn't make sense, because you would have to throw out enormous amounts of stuff to make any difference.

NORBERG: Yes. Now, this sounds to me like most of the work was going on inside the office, that the helpers were really not helping very much in terms of strategic planning.

HERZFELD: No. It was more balanced than that. We were constantly inundated by ideas, some good, some not - lots of good ones. So this was a very lively time. People would come in and out all the time with new ideas. And there were indeed many places where they could sell these, but in the end they would come to us. So there was a great traffic of ideas, flow of ideas. That was very interesting. Same as here. Nothing has changed except the details.

NORBERG: [laugh] How were contracts let out of the Defender program?

HERZFELD: The basic ARPA technique, which is still the DARPA technique, is that the director signs an ARPA order, a DARPA order, that goes to a department - Army, Navy, Air Force - that says, "You will execute the following contract through your contract people, with organization X, work statement such and such, dollars in this ball park, and go do it please." The beauty of the DARPA arrangement - which started in 1958 - is that it can do that. It is the only organization in the Defense Department that can, really. Just about the only one of any size.

NORBERG: But what's the advantage of that sort of contracting routine as opposed to the usual procurement that the military services do?

HERZFELD: Speed. DARPA still is, and was then, bound almost all the time by all the regulations. But the judgement was applied in DARPA, as it is now, and at as high a level as was necessary, and if necessary, with clearance from the DDR&E or the Secretary, and was in some major occasions. It wasn't a matter of months and months of arguing at low levels about should one do this, should one do that; it was all taken care of. The Services did not have the option to say no to the content, to the material, and they had to use the most expeditious form to get there.

NORBERG: Two things are running through my mind simultaneously here. I am trying to sort them out. What sort of interaction did you have with Ruina when you came?

HERZFELD: Very friendly, very frequent, very informal and pleasant. He would wander into my office whenever he felt like it, and I would go see him whenever it was necessary - several times a day usually, on the phone with each other, lots of meetings together.

NORBERG: What went on during these meetings?

HERZFELD: Well, I would tell him, "Look, Jack, I really..." For example, "In order to get this comparison of the U.S. penetration aids and potential Soviet defenses together, we have to get one contractor that really handles all of the data. This contractor has to be able to get all the clearances - a very sensitive matter; the most sensitive then around. And if I can't do that then I can't do the job." He says, "Fine, who do you have in mind?" I said, "Well, A,B, and C." He says, "Fine, sounds great to me. Go do it."

NORBERG: Was this a fairly typical interaction?

HERZFELD: Yes.

NORBERG: Do you think this was fairly typical of other program managers as well?

HERZFELD: Yes, absolutely.

NORBERG: Did you ever see any of that with any of the other program managers?

HERZFELD: Oh, yes. There always is a difference depending on the degree of confidence and so on that exists between people, but the office directors were really the key players through most of the history of DARPA, I think. And good, strong office directors could do basically what they thought was necessary with a minimum of interference or quibbling, because the directors would tend to support them. And the office director went up the line if need be. There was very rarely any real problem.

NORBERG: That was my next question. How often did you go up the line with him. Did you have interaction with other people like Harold Brown?

HERZFELD: Harold Brown, or Johnny Foster, who was my boss for most of the time when I was director. I would see Johnny several times a week. We would talk almost every day. "We need money," or "We need an okay." I remember most vividly in terms of your area of main interest, the ILLIAC 4 discussions where Johnny was very unconvinced that the parallel machine was the thing to try. And I was really persuaded that that was the thing to do. And he finally did it. I mean, we only did a machine one quarter of the size that we wanted to, but it was plenty big for those days. Some people would say a little too big.

NORBERG: [laugh] Do you remember his arguments in opposition to parallelism?

HERZFELD: Well, the speed of the machines that were then being designed were really at the edge, like STRETCH and STAR and so on, would really make up for the complications of the...

NORBERG: I see.

HERZFELD: It was a gamble and he didn't think we should gamble, and I thought we should. And finally, eventually he let us go on our way.

NORBERG: The second thing I had in mind was what do you think prepared you for this job to straighten out Defender?

HERZFELD: I had acquired at the Bureau a reputation as a good manager of complex technical programs, and had a wide technical background, had learned about a lot of different things. I was interested in military problems from very early on. I knew a lot of people in the defense expert family. Everybody told me I was a good manager. I thought it was an important thing to try. So I tried it.

NORBERG: I am looking for the other side, of course: why they tried you.

HERZFELD: You will have to ask Jack Ruina. [laugh] I don't think he is unhappy that he tried me.

NORBERG: Oh, I don't think so at all, no. But you mentioned being familiar with the problems in the defense community and knowing a number of the people who were considered expert at the time. How did you come to know these people? Was it through the Bureau?

HERZFELD: Partly through the Bureau; partly through my interest in arms control issues, which were just beginning to surface then. I was always interested in military problems and arms control became kind of the vogue. At the Bureau I had only limited contact with military problems as such, but it was easy to keep in touch with the arms control community. That's where I met Jerry Wiesner before Kennedy was elected, Kissinger later. I have known a lot of these people.

NORBERG: Another incidental question occurs to me just for completeness here. Had you had much contact with the White House in the early 1960s if you knew Wiesner and other people who might have been on PSAC?

HERZFELD: The answer is yes, a fair amount. Not as much as some people around here, but a fair amount. The ABM issues were at PSAC, of great interest to PSAC, and to Jerry. Jerry and I were on very warm terms, very friendly, though we disagreed on some policy issues. He was always totally opposed to ABM. But I thought then and still do that a balanced posture with some ABM is better than an unbalanced one. That argument hasn't changed very much, either.

NORBERG: Yes. Did you sense that there was any influence of the White House in DARPA in the early 1960s?

HERZFELD: Very much so. Most of the things that DARPA did were White House initiatives: the Defender program, the space program, the Nuclear Test Detection program, to some extent the computing program, were White House initiatives. They started with PSAC; went through the science advisor; the president approved it; the president assigned it to the Defense Department; the Secretary of Defense assigned it to ARPA. So they were not White House programs in the sense that they were run from the White House, but they were national problems. In fact, I am one of those who says that DARPA should work primarily on defense problems of national importance. I define a national problem as one the Secretary of Defense is likely to discuss with the president at their weekly lunch, you know, or at least several times a year. That is my operational definition of a national problem. I think anything else that DARPA does may be a waste of its special talents.

NORBERG: Well, how would you justify...?

TAPE 1/SIDE 2

HERZFELD: Let me repeat that. There were a few people in 1960, '61, who thought on technical grounds and kind of a good imagination, that there was more to computing than what the big commercial makers of computers had done,

and that one could do something very exciting, very important that would really change the way people worked, the way they thought about problems, the way they solved problems. And I think Jerry was one of those.

NORBERG: Jerry Wiesner.

HERZFELD: Yes, and Jack Ruina was one of them.

NORBERG: That's interesting. I don't find any evidence of that, though I have not talked to Wiesner. We did talk to Ruina, and he was somewhat vague on those years as to just what his interaction was with Licklider and others.

HERZFELD: Really?

NORBERG: Yes.

HERZFELD: Interesting. He hired Licklider.

NORBERG: I am not sure why that is the case, but he just simply was nonresponsive. And he tried to be; it wasn't that he was hiding anything. You just gave me an idea. I have not looked in the Kennedy library papers, and it may be that might be a possibility for...

HERZFELD: The thing to look at, I think, is the PSAC agenda. You know somebody who would know - Charlie Townes, probably.

NORBERG: Oh, all right.

HERZFELD: He is still around, and his mind works beautifully well. Charlie was involved, and I remember him asking me about Defender, and computers and stuff. Let's see, who else besides Jerry could have been...? I have my papers,

most of them, somewhere, because I don't throw anything away - to the despair of my family. The question is, I do not know which batch they're in. I have just moved not long ago, and so it may be in my new house, but I do not know in which boxes, unpacked, or in which filing cabinets. It may be in one of these boxes out there; it may be in one of the file cabinets, or in this one. But there is something there. At any rate, I can report the current feeling that I thought then that computing was one of the really exciting things that was going on - new computing. I am now convinced that I thought that then, to make a very precise statement, I am sure it is true.

NORBERG: All right. Then let me try to explore it by soliciting some details from you by asking you specifically about your interaction with Licklider during those years. I am speaking now between 1961 and the time he left.

HERZFELD: Which was 1963.

NORBERG: Yes.

HERZFELD: Well, he saw to it that I saw demonstrations of interactive graphics. I went to MIT for that, I believe. He saw to it that I heard about time sharing, because we were interested in getting more efficient use out of computers.

NORBERG: Was he doing this with all the program directors?

HERZFELD: I really don't know. I assume so, at least with some of them, because in the nuclear test detection arena... Well, Bob Frosch was there then and he, of course, became a great advocate. Well, let me give you an example; I do remember this. It may have been after Licklider; it was a Jack Ruina idea. In nuclear test detection, underground nuclear test detection, ARPA decided to build the large aperture seismic array. I remember the discussions vividly, because Ruina got Frosch and me together, maybe somebody from computing, and said, "Look, why don't we try and see if one can use radar, phased array radar techniques for seismology. All you need is a big aperture; you need a lot of elements, and with time delay you can beam steer." You see, the Defender program had

built the first phased array radar - Westinghouse, the ESAR, which had some hundreds of elements, it was a UHF radar, as I recall, and electronically beam-steered, both for transmit and receive, by just time delay, not hard to do. It is computing intensive. And it worked, as one would expect it to. And so then there were these discussions, and the seismologists went off and said, "Yes, we can have a couple of hundred elements spread over a hundred miles squared, tied all together, and have a big computing center in this somewhere, we can, not in real time, of course, but after the event, beam steer. You take all the data; we have got good clocks and so on. It's easy. And you just calculate what you got - no big deal. And you can search, in fact, among all the data you have. You can do a virtual beam tracking and see if you find anything interesting - beam steering." And the answer was that it changed geology and seismology. And we knew that that's what we were doing. And Frosch and I once sat - he was my deputy at the time; I was director, so this was when the thing actually happened; it had started a few years earlier - he said, "You know, this is going to change geology forever." Just a different subject.

NORBERG: Did it take any special computing to do that though?

HERZFELD: Enormous amounts but fairly standard techniques.

NORBERG: Yes, there would be very large amounts of calculation necessary and on a real time basis, but it wouldn't require any specific new machinery, would it? I mean, you could have done that with the machines...

HERZFELD: It needed some netting, as I recall.

NORBERG: I see.

HERZFELD: Yes, just for the practicalities, because you had to digitize information. There were a number of complexities about it. But it's not quite on the Licklider kind of computing. It was clear that modern computing was beginning; artificial intelligence was beginning, and a rule-based expert systems were beginning, the sort of interrogative thing. What was that program called? It sounds like you're talking to an individual; all that the

computer does is rephrase your questions and so on. And I think I was one of the earlier people to explain AI to the Congress, because I had to defend the budget and they asked, "What is this?" You can find that in the hearings.

NORBERG: Yes, I have already.

HERZFELD: But there were just a whole bunch of things that were going on around this. They really got the first big shot in ARPA from Lick. It just convinced me absolutely that it was a new day.

NORBERG: I need to clarify something. In the *Who's Who* entry, it indicates you were an assistant director at ARPA from 1961 to 1963. Is that when you were doing the Defender program?

HERZFELD: Yes.

NORBERG: And then you became the director of the Ballistic Missile Defense in 1963.

HERZFELD: No, there was a complication. The Defender program had two parts for a while. And I was in charge of one, the science and technology part. But the fellow that was in charge of systems reported to me. It was not a unified structure. It was something that Ruina could not arrange at the last moment. And finally, six months before I left the Defender program I was officially made the director of the whole thing. It was a bureaucratic wrinkle; it had very little practical significance.

NORBERG: You became deputy director at DARPA in 1963. Is that correct?

HERZFELD: That's right.

NORBERG: And then director in 1965.

HERZFELD: Yes. The way I explained it was for two years I ran half of ARPA, and then for two years I half ran all of ARPA, and then for two years I ran ARPA. [laughter]

NORBERG: Now, when you were deputy director of ARPA, did your association with program directors change from what it had been before? What were your new duties? It's another way to ask the same question.

HERZFELD: Well, Bob Sproull was the director and I was deputy director. And Bob Sproull... Well, he was heavily involved in everything. He was a very good director. He and I worked very closely, by the way, so that he would let me handle all kinds of things. So basically again, when an office director and I agreed, Bob Sproull would go along with it unless he had a very weighty reason not to. So I pretty much was able to do what I thought needed to be done.

NORBERG: And what is it you thought needed to be done?

HERZFELD: Well, we continued the Defender program, which was zeroing in on fewer options as time went on, and more capability. In the computing we started the new initiatives: the networking, the parallel machines, roughly in that time frame. And time sharing had been done, and interactive graphics was well on the way. More AI came along; more emphasis on that, as I recall. We began to try and think of uses of some of the new technologies, as I recall, in that time frame. Then in quite different arenas, the materials program was quite mature then, was doing well. Bob was spending a lot of time on that, but I was too. We had stopped the chemical propellant program, which had been started in 1958 or so. We figured enough had been done. The nuclear test detection program changed after the three media test ban treaty (which banned nuclear tests in the atmosphere, the ocean, and space), and became much more absorbed by detection of underground tests. We put up the satellites to make sure there was no cheating - the VELA satellites. And that went well. We put more effort on seismology and other ways... We were looking for all kinds of ways, including the famous beetle story. Beetles, depending on how close they are to an underground explosion, are crushed to various degrees? So it was probably similar to looking for anything that might enable one to detect the cheating event without on-site inspection, which in those days was rather visionary. We got more and

more involved in Vietnam - Project AGILE became a big preoccupation. We spent a fair amount of time on that. Those are the major things.

NORBERG: Yes. How much did time did this leave for considerations of computing then?

HERZFELD: I thought that my job vis -a-vis the computing program, when I was deputy director and director, was first of all to make sure to get the best office directors we could get, and second, to help them do what they thought they needed to do, and third, to look for applications across the projects for computing, when you apply the new computing ideas, technology and its capabilities as widely as possible.

NORBERG: Okay, so I see two different kinds of strategic planning going on here, if we can call even one of them strategic planning. One of them is whatever is coming from the White House or from the Secretary's office in terms of projects that would be requested from DARPA. Now that, it seems to me, is sort of serendipitous. It's the sort of thing that emerges from events, if I understand all of that.

HERZFELD: Yes.

NORBERG: ... historically correct.

HERZFELD: Yes, very much so, I think.

NORBERG: On the other hand, once DARPA has these tasks in hand...

HERZFELD: How you do it.

NORBERG: How you do it, and...

HERZFELD: It is opportunity-driven.

NORBERG: All right. And then what you do with it after you have some results, is that also opportunity-driven?

HERZFELD: Yes, largely. And I think we were in a position to know the military needs and the problems of the military.

NORBERG: How did you know that?

HERZFELD: Unless you positively avoided it you had to learn it, because you were in the environment, and it was very real, especially after the war was going, and the crises with the Russians and so on. We had plenty of reminders.

NORBERG: Yes. Well, I guess what I was trying to get you to describe perhaps would be examples of when you would be interacting with military personnel in which there would be an exchange about, "If we had this, we could do that," and so on.

HERZFELD: Well, let me give you examples on this penetration aid problem I mentioned. I personally briefed the Joint Chiefs of Staff several times - three or four times in the five years or so that this was an active issue - and got into long discussions and debates with some of them about, "Are defenses possible? Can one discriminate decoys from the real thing? Can the other fellow do that?" This very quickly turned into sensors and computing.

NORBERG: Can you be more specific about that?

HERZFELD: A little bit. What kind of radar does it take to make the kind of measurements which, with adequate computing, can tell you that the signal is from a decoy and not from a re-entry vehicle? A very big question, always; it still is. And so the relative ability to compute is a key item. And many of these people were well-informed; others

were less so. Lots of discussions with their staffs. We had our own military staff members. DARPA then, as now, had a fair number of quite experienced military people and they would speak their minds, e.g. "I think this is silly." We would try and have a sensible discussion, you know, and one persuaded the other, or neither did either. Out of that came a great deal of learning and understanding. Being director of DARPA is the best post doc arrangement I know. There is none other like it.

NORBERG: Everybody says that about being program director as well.

HERZFELD: Oh, yes. That's also true.

NORBERG: It seems that...

HERZFELD: Oh, yes, it's just a different level, see. This is hard to convey, because these things often are also opportunistic and rarely documented, and one's memories are very unreliable witnesses of the gleam in the eye. You sit in a briefing and I say to myself, "Oh, boy. I know what to do with what I am hearing about." And these people never thought of that. And you get a whole team of people together the next day and say, "Hey, how about you try this on that?" And they say, "Well, you are crazy! This will never work." And you say, "Well, don't be sure. Why don't you guys go off and do some calculations." And X and Y and Z go off and do some calculations and we'll see. And they come back and say, "Well, maybe a small chance." And you say, "Well, can we afford a half a million bucks on it? Who is the best bunch to work on that and give us a quick answer?" Is it silly or will it work? It happened all the time.

NORBERG: Considering the years in which you were program director, then deputy, then director of ARPA, the areas that are now sort of apocryphal in terms of contributions made to computing, things like time sharing and networking, were really just being developed - 1963, the first time sharing systems become available on almost an experimental basis. Networks are 1969, or thereabouts.

HERZFELD: Well, the networks... I signed the first ARPA orders for networks in 1966 or 1967, and then I left. So all that happened after I was gone. But I had long discussions about them. People explained to me what the idea was and why, why these three universities and not three others, you know, and so on. And I remember those orders.

NORBERG: What I was going to move you toward is a possible analysis of what sort of discussions could be held in those preliminary days about how to apply this to problems of a different kind - problems in the military, problems in the economy. That is, how do you stimulate companies to provide this sort of equipment if you think it's going to be useful in the military, and so on. Did any of those discussions go on in those early years?

HERZFELD: Oh, yes, absolutely. We felt there should be more than one supplier of large computers. Everybody thought that the one supplier was just very conservative technically, so we were kind of hungry for more alternatives and that was hard to do, because of, you know, competitive procedures and so on. So I don't want to say too much about that, but it certainly got talked about. Some things were done that were perfectly okay, but...

NORBERG: Well, there certainly was stimulation of other companies through two contracts.

HERZFELD: Of course. Right, that's exactly right. Yes, the thing was to try to find appropriate things for other groups to do and fund that. On the networking and timesharing, the combination of the two, it was clear that, for example, for quicker war time planning of military action it would be very useful if you would be able to access a database in Omaha and have the planning staff here, and send the execution orders to the SAC bases. That hasn't happened yet, but it may happen one of these days.

NORBERG: But when it was discussed in the office, did any of the military people say, "Oh, that's crazy; you can't do that"?

HERZFELD: Well, there were some that said "You shouldn't do that." I don't think many people said "You can't do it."

NORBERG: It's certainly a different... Can we talk about ILLIAC 4 for a few minutes?

HERZFELD: Sure. I am running short of time.

NORBERG: Yes, I realize that.

HERZFELD: We can get together again, by the way, if this is useful to you.

NORBERG: We may have to. If you would be generous enough, I would appreciate it. Okay. Can we just chat a few minutes about ILLIAC 4 then? Do you remember how you became involved in discussions about ILLIAC 4? Was it brought to you by Sutherland?

HERZFELD: It was brought to me by... I forget who the office director was, whether it was Larry, or Ivan Sutherland, or...

NORBERG: Well, Sutherland succeeded Licklider, and Taylor succeeded Sutherland, and then Roberts succeeded Taylor.

HERZFELD: Yes, that is correct. So it may have been Taylor. I don't remember really who the individual was, but the idea of parallel processing when it came to me was new to me, except for some vague rumors, but the office director came in and said, "Look. We have got an opportunity here to try something really new. It's very big. Think about it." And it was, of course, related to the University of Illinois group, and... What was that man's name?

NORBERG: Slotnik.

HERZFELD: Slotnik, and his dream. So I went into that a little bit and asked about the ILLIAC 3 and so on. What

happened, and so forth. A little history. But it was clear that parallel processing, a single instruction, multiple data machine, for example, would be great to do simple hydrodynamic problems, for fluid dynamics in general. It would just do differencing all over the place. Similarly, you could calculate pixels in parallel for big displays. And you have to have some strategy for doing that so you don't lose track. And that's one way you get numerical solutions to treat fluid dynamics problems. Now, I knew enough about that - and I thought it was important - because I had spent a couple of years at Aberdeen where I was working on the interior ballistics of guns, and I knew people were trying to model this. I knew the nuclear weapons people were trying to do hydrodynamic calculations for what was going on when the weapon goes off, and so on. I knew the ERMA (?) people. The flow of materials, in general. And I knew enough about it technically that it's a pain in the ass to do it the old way - very inaccurate, very slow, hard to do different cases, and so on. So if there was to be found a way to do that fast and accurately, that would be wonderful. So that was one of the major applications - applications to ASW and the designing vehicle that fly in real fluids, and so on. So it immediately appealed to me as a very, very powerful idea. Then really, the rest was taken up with practicalities - you know, how much? How big? Why not something else? And it just took months and maybe a year of arguing in the building and outside.

NORBERG: When you were faced a question of this kind, whether or not you would fund an ILLIAC 4 or whatever, networking, and it was something that had not been in your budget for that year, how would you go about funding this sort of thing? Would it have to wait until the next cycle?

HERZFELD: No, the way we usually did this is we put a small early step into the program. We started the program with a small step that we just simply reprogrammed from lower priority things. In an organization that large that does that many things you can always find, you know, lower priority programs in the budget. You really can. Now, other people may be very unhappy when you reprogram, but you can. And we did it, and they still do it. It works just fine, thank you. And then you go to the Congress and explain that you are going to do this and that next year if it pans out you will be back for more funds, and you have to get that all agreed to here, you know, if you do. We always used to have an easy time with that; DARPA still does.

NORBERG: Yes. When you say agreed to here, does it have to go all the way up to the Secretary?

HERZFELD: Usually not. But, you know, the controller would have to agree. The staff.

NORBERG: Because Taylor has made a big point about the beginning of networking in saying over and over again in various speeches that he has made, that when he came to you about the possibility of doing a network project that you immediately gave him money from one of the missile programs, and that he had a half a million dollars in the course of a 30 minute discussion.

HERZFELD: Yes, absolutely.

NORBERG: Do you think that's right?

HERZFELD: Absolutely. You know, I used to say that ARPA was the only place in town where somebody could come into my office with a good idea and leave with a million dollars at the end of the day. And this is sort of still true; it takes a week or two now.

NORBERG: Let me ask you one more question, and that is, did you ever make site visits while you were either deputy or director of ARPA?

HERZFELD: Not to the ILLIAC 4.

NORBERG: Anywhere.

HERZFELD: Oh, sure. I traveled a lot.

NORBERG: Do you remember places you went to specifically associated with computing?

HERZFELD: Well, I went to MIT a number of times. I went to the GE plant in Phoenix where they built one of the fast computers for us. I think it was in Phoenix.

NORBERG: Yes, that's correct.

HERZFELD: I looked at some computers in the field. I went on board ship. I looked at the SAC computers just to see how it's done, and comparing that in my mind with the future that had been painted by people like Larry and Bob and Ivan and Lick, and say, "Well, this is slow; this is old fashioned. This one can do better."

NORBERG: Did you take any of these people with you on those site visits?

HERZFELD: Sometimes; sometimes not, you know. Everybody is pretty busy. I liked to have some experts along. There are some advantages to not having anybody along, because people will talk more foolishly if they think there is no expert around. If you know more than they do, you find out fast.

NORBERG: [laugh] I thank you very much for the time you spent this afternoon.

END OF INTERVIEW