

An Interview with

JULES I. SCHWARTZ

OH 161

Conducted by Arthur L. Norberg

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Abstract

Schwartz worked for the Rand Corporation on various defense related projects: SAGE and Johnniac in particular. When Rand organized the System Development Corporation, Schwartz went to the new company. For most of the interview, Schwartz describes his association with SAGE, his part in the computer laboratory work on timesharing for the AN/FSQ-32 computer, computer networks, control system projects (such as TDMS), and his interactions with ARPA personnel, including J. C. R. Licklider, Lawrence G. Roberts, and Robert S. Taylor. He discusses his later position at Computer Sciences Corporation. This interview was recorded as part of a research project on the influence of the Defense Advanced Research Projects Agency (DARPA) on the development of computer science in the United States.

JULES I. SCHWARTZ INTERVIEW

DATE: 7 April 1989

INTERVIEWER: Arthur L. Norberg

LOCATION: El Segundo, CA

NORBERG: This is April 7, 1989. I am in the offices of Jules I. Schwartz at Computer Sciences Corporation in El Segundo, California. Can we begin today by my getting some personal data from you? I am interested in your birthplace, your background, education, and so on.

SCHWARTZ: Okay, my birthplace is Philadelphia, Pennsylvania. Education -- I have a bachelor's in math from Rutgers University and a master's from Columbia. I never went on for the Ph.D.

NORBERG: In what year did you get the master's?

SCHWARTZ: The master's was 1961, but that was ten years after I got the bachelor's. I had been in the Army a couple of times -- once in the Korean War, and once at the end of World War II. Then I moved out to Rand Corporation and worked, and then I got sent back to New Jersey. I finished my work that I had started at Columbia while I was in New Jersey right across the river. So that is why I took ten years between the bachelor's and the master's. I got married... And anyway, it delayed a lot of things. I took some other graduate work in mathematics, but never went on or tried for a Ph.D. Let's see, what else?

NORBERG: Well, if you got your master's degree in 1961, is that when you went directly to SDC, or was there something intermediate between that?

SCHWARTZ: Oh no, that happened at Columbia University. I was there right after I got out of the Army the second time. I was in Korea and came back and went to Columbia. After one year at Columbia graduate school I decided to get married and go to work. So I came to Rand Corporation in 1954 -- Rand, not SDC. Then I went back to work on the SAGE project at the end of 1955. That was at Lincoln Laboratory with a lot of people who were originally MIT

people, and Lincoln Lab people. I worked there for a couple years, and then came back to California. I was still with Rand, but then in 1957 that became SDC, or part of it. Anyway, after a couple of years I got sent back to 465L -- one of the big command and control systems. This was for SAC -- the Strategic Air Command. That was probably 1959. That project was where the JOVIAL language/compiler effort started. I stayed there until 1961. While there, I went back and finished at Columbia. I had only one more course and a paper to write, so I accomplished that. So I had been working at Rand since 1954, had started working with computers in 1953 at Columbia at the IBM Watson Center with a man by the name of Eric Hankam.

NORBERG: Hankam. How do you spell Hankam?

SCHWARTZ: Probably H-A-N-K-A-M, but to be frank I do not know. He used to teach their courses at the TJ Watson Center within a block or two of Columbia University. I do not know if he is still around. The 650 was announced during that period. I was introduced to 602As, 604s, equipment like that at that course.

NORBERG: Now, when you finished the work at Columbia in 1961, were you on leave from SDC?

SCHWARTZ: No. I just had the one course and a paper to write, so I was running over there at night to finish at Columbia. I enrolled in a course in mathematical statistics, which was my major.

NORBERG: In the period from 1959 through, say, 1961 or 1962, what sort of work were you doing?

SCHWARTZ: 1961 was when I was back on time sharing.

NORBERG: Okay, prior to 1961, what sorts of projects were you working on? You mentioned SAGE, but I did not hear about anything in between SAGE and...?

SCHWARTZ: Oh, okay. Originally at Rand Corporation almost everything I did was on the Johnniac system. Of

course, at the time Johnniac was quite primitive compared to what existed just within a couple of years. I wrote utilities for the Johnniac system. Then I got involved in one of the early, or first, automatic coding technique projects called PACT.

NORBERG: P-A-C-T?

SCHWARTZ: Yes. We wrote a series of papers and gave them to the ACM in either 1955 or 1956. People like Owen Mock, Frank Wagner, and Wes Melahn, and Chuck Baker from Rand were there. It was a cooperative effort among about seven organizations: Douglas, North American, Rand, China Lake, others, as I recall. It was developed for the IBM 701.

NORBERG: What was PACT for?

SCHWARTZ: It was a programming language for automatic programming. It started at about the same time as FORTRAN 1. Actually, when you look back at it, it was a very elementary step forward. We, of course, thought it was great. Then FORTRAN 1 came out, although the PACT project still continued for some years -- three or four, I think. It went on to the 704 computer. I was off it by then. Tom Steel of Rand/SDC was involved at that time. Have you ever heard of Tom Steel?

NORBERG: I have heard the name.

SCHWARTZ: He was very involved in the original Share activities -- SOS, etc. Anyway, PACT just kind of died away. In those days, of course, everything was machine language. There were various forms of assembly language, and PACT and FORTRAN were an attempt to get away from them, but FORTRAN, of course, won that battle. It was not even really a battle. Anyway, that went on, and then I left for SAGE about December of 1955. I stayed there until 1957 and then came back.

NORBERG: What was Lincoln Lab like when you were there between 1955 and 1957? You were on SAGE.

SCHWARTZ: Right.

NORBERG: You mentioned Lincoln earlier.

SCHWARTZ: Yes, right. Well, prior to that Lincoln Lab had developed a prototype air defense system on the Whirlwind computer. Based on that, the Air Force decided to go into air defense in a rather major way with the SAGE system, which was SemiAutomatic Grounded Equipment. Many of the people who were managing that effort were Lincoln Laboratory people -- people like Herb Bennington, Jack Arnow, Charles Zraket, and others who were ex-MIT people. I think the project had this close association with MIT up until the point at which it became a big Air Force project. It was an environment that was interesting in the sense that at that time, of course, there were not many programmers, and we probably knew almost every programmer around the country, until that project started. Then SAGE hired, within a year or two, about a thousand to two thousand people.

NORBERG: Lincoln hired the 2000?

SCHWARTZ: Well, Rand...

NORBERG: Did they hire them just for that project?

SCHWARTZ: Most of those hires were Rand employees. They, plus some people from out here, became the nucleus of SDC. Jack Arnow, who was the manager, was once asked in a meeting some years later, what he would have done differently if he had to manage that project again. He said, "I'd probably hire ten smart people and do the whole thing." But of course, when you get down to practical matters, you cannot do it that way either. But anyway, they had a tremendous number of people, and it mushroomed into one of the first large conglomerations of programmers. You still see a few of those programmers around. They had a big programmer training effort.

NORBERG: What I was also thinking of when I asked you that question is, can you contrast the way in which Rand was operating the structure -- whatever is the right word -- and how Lincoln was structured and operated? Lincoln, after all, was connected with a university or institute whereas Rand was freestanding and connected more closely with the military -- with the Air Force.

SCHWARTZ: I do not know. My impression was that, considering the times, Lincoln Laboratory had, engineering-wise, set up a rather good scheme for designing, developing requirements, programming, keeping records, and developing some very interesting basic software, which at the time was unusual. Better than what I would have expected, when I look back now. Don't forget, most of us Rand people were new and brought together from a variety of places. Some of us had some experience back here in California, but the vast majority were new hires, people who had never programmed before. So Lincoln Laboratory served as the nucleus of the engineering and design of the system, and the experience with the hardware, which was IBM hardware -- a Q7 computer. We "experienced" programmers from Rand had generally worked as individuals or part of small teams on small projects. As the years wore on, SDC took a much more active leadership role. But by that time I was out of the system. By 1957, I had nothing more, or very little, to do with SAGE. That is the best I can say.

NORBERG: What I was looking for was some way to then see what went on in the early 1960s as sort of a continuation of attitudes or views, and so on, between the two organizations. But that may be hard to say at the level you were at.

SCHWARTZ: Yes, I myself became a project head at the end of the SAGE project, came back to Santa Monica with SDC and led several small technical efforts somewhat related to the work we had done at SAGE. It went on for a year or two like that. In around 1959, ALGOL -- IAL at the time -- was proposed, and some articles in the *Communications of the ACM* were published, which gave us some insight into how to do things such as expanding algebraic expressions and things like that. At approximately that same time, I got together with a couple of guys at SDC and we went ahead and played with that sort of thing. But then I got sent out to the 465L project in Paramus, New Jersey,

with IEC as the prime contractor.

NORBERG: IEC?

SCHWARTZ: Yes. It was formed, I think, for the contract. It was a subsidiary of IT&T. Based on our SAGE experience and what it took to develop a rather large, for the time, command and control system with data base problems (of course, data base is different today), and programming problems, inflexibility of machine level programming languages, and the knowledge we had had at the time of ALGOL (or IAL), and some other things learned at SAGE, SDC became a major part of the development effort for 465L. I got involved with the JOVIAL language, which was based somewhat on the things learned in SAGE. Included were concepts such as the communication pool (compool) and a variety of others which were introduced during the development of SAGE, so that 465L (SACCS, as it was called) could be written in a higher level language. At that time this was quite unusual (the first such system development).

NORBERG: While you were on that project were you still an employee of Rand?

SCHWARTZ: By that time I was at SDC.

NORBERG: All right, still an employee at SDC, just working at IEC.

SCHWARTZ: Right, another temporary visit to the East Coast for two years.

NORBERG: (laugh) It hardly seems temporary, you know.

SCHWARTZ: No. We did not have our own car, we did not have any of our children's stuff, and my wife had another baby. Everything, including diapers, was rented. It was that kind of thing.

NORBERG: Can I ask you one question about the famous 2000 who were hired for the SAGE project, many of which came through Rand? What sort of backgrounds did these people come from? Were they largely in mathematics or some other...?

SCHWARTZ: I think the basic requirement was one year or two (maybe one year) of calculus. They had some requirement like that. I remember an undertaker, a trolley conductor, a number of teachers who had been in math teaching. At that time, of course, there was no computing course or college degree in computing. It was a new field. One guy was a curtain cleaner, I remember that. The people did have to pass the Rand programmer aptitude test, I believe.

NORBERG: That seems rather optimistic to me to hire people like this to do this sort of task.

SCHWARTZ: Yes, as I recall, they gave them 17 weeks training, unless I am mixing that with the 17 week Army basic training. Whatever the duration, the training evidently was pretty good. Of course the programs at that time were not very large individual programs, and they were engineered pretty well and managed to communicate with each other. So the individual's task was not that big. The specs were generally pretty good. The computer was not sized well as usual. In those days they started, as I recall, with 8k of memory, 8k words, and grew to 65k or something, which was quite a shock then, for 1956. But anyway, yes, it was ambitious. And many of the people were probably not meant to be programmers. Some developed quite well, and some are still in the field, of course. I worked with several who have been with me in other projects over the years. One is now a VP with CSC out on the East Coast. There are some others who are also with CSC as vice presidents. One who was very active in SAGE training and some other things eventually went to Xerox... He died recently. I happened to read his obituary in the paper the other day -- Guy Dobbs, who became well-known over the years in one way or another. He was on the board of Xerox for a while, I believe.

NORBERG: Oh yes.

SCHWARTZ: Some did not continue in the field. But there was nowhere else to get people. As Jack Arnow said, "Hiring people became the solution for everything." [not an exact quote] There was one thing I did not mention: many of those people were hired not just to program the system. Part of the problem with SAGE was they had sites all over the United States -- I can't remember how many, 25, or some number like that -- and they had to hire people to man those individual sites. So many of them were called implementation people.

NORBERG: Now I see. Okay.

SCHWARTZ: They learned programming, and they could program eventually, but they were not programming this system. I do not really know if it was 2000 people. It was numbers like 1000...

NORBERG: Well, that is a number that has been quoted: not only 2000, but greater than a thousand. In the special issue on the SAGE for the *Annals of the History of Computing* this problem is explored in terms of the large manpower applied to a problem where you probably could do better with ten people if you did it correctly from the beginning. I do not remember all the details now, but it is discussed. What was not discussed was where they came from, so if I was going to add that...

SCHWARTZ: I was involved, in fact, in the 1969 conference on system engineering. It was held near Rome, Italy. I think it was the second one. It was in 1968 or 1969 where the...

NORBERG: ... famous NATO conference's were held.

SCHWARTZ: Yes. Where the famous "string of pearls" speech was given by the Dutchman.

NORBERG: Dykstra.

SCHWARTZ: Dykstra, yes. I gave a couple of short, informal talks, which were quoted in there. There was one main

paper I presented -- (I don't even remember what I talked about), but informally I mentioned some of these issues that I recalled from SAGE and SACCS which are in the footnotes of the proceedings -- that touched on the issue of whether you need a mass of people to solve the problem, or whether you create the problem by hiring a mass of people -- that sort of thing. There was always a question about that.

NORBERG: Okay, turning to 1961. You returned to California and back to what would be SDC headquarters, I assume, and you were assigned to a new project.

SCHWARTZ: Yes. It was either 1960 or 1961, but it was in that period. Before that I almost got hired by Informatics. I went and talked to Herb Bennington, who was an ex-Lincoln Lab manager, who now was a vice president, or whatever, at SDC, and told him that I was thinking of leaving. He said, "Look, we need somebody, because Licklider was about to kill the SDC ARPA project." The only thing that was going to save it was the use of the Q32 computer, which had been intended for what was called "SuperSAGE", the next development, but was canceled. SDC ended up with that computer, which at the time was a large mainframe, compared to many others, and government sponsored. At that time Licklider was proposing his man-computer symbiosis ideas, and he had the idea that we should have a time sharing system on the Q32 computer which would service universities or researchers around the country, or wherever. So Bennington convinced me that rather than go to Informatics, I should take over that project, because they had nobody to lead it at that time. So I agreed that I would.

NORBERG: Okay, let's go back for a minute, because there is a bit of confusion on dating there, I think. Informatics was founded in 1962.

SCHWARTZ: Was it 1962?

NORBERG: Yes. You mentioned that you finished Columbia in 1961.

SCHWARTZ: Yes, I got the degree in June of 1961. Oh, I was not at the commencement, but I think I was still in New

Jersey. But that is right.

NORBERG: Licklider came to ARPA at the end of 1962.

SCHWARTZ: Okay. Then I am off by...

NORBERG: My last fact to throw in here is that the Q32 came here before Licklider went to ARPA.

SCHWARTZ: I believe that, yes.

NORBERG: Yes, all right. Now, if the Q32 was here, or possibly shipping, or whatever, during 1962, was the idea of making a time-sharing system for the Q32 prior to when it arrived, or was that decision made some time later?

SCHWARTZ: I am pretty sure it was after. The Q32, as far as I know, was originally delivered to start work on the SuperSAGE. I was not involved originally.

NORBERG: Okay. But delivered out here for that purpose.

SCHWARTZ: In SDC in Santa Monica, yes.

NORBERG: Okay, then SuperSAGE is canceled, and you have to find a use for the Q32.

SCHWARTZ: Right, and that must have been when they got the ARPA contract. I was not there then. So it must have been 1962. Right, because I got my degree in June of 1961. As I said, I do not know if I was still in New Jersey.

NORBERG: Yes. Now, SDC has a contract to develop some sort of time-sharing system before the Q32... whenever that occurs; we can look up the exact date. I do not care about that so much as I do about Licklider, that it looked as

if he wanted to kill this. How soon does that take place? If he did not go to ARPA until late 1962, and really is beginning to flex his muscles in early 1963, then when did he begin to make noises about that?

SCHWARTZ: I am confused about that. I would swear that it was before the end of 1962.

NORBERG: Okay. Let's go back, then, to when you came back here, which we are going to claim for the moment was sometime in 1961. Is that fair enough?

SCHWARTZ: Yes.

NORBERG: Let's say the summer of 1961, just to get out from some of the details here. Do you recall what it is you were working on when you returned?

SCHWARTZ: I know, it must have been in the early summer or late spring, because I think that it was when my third child was about six months old, and she was born in September of 1960. So I must have come back and spent...

NORBERG: Okay, but you do not remember what you were working on? Was it on SuperSAGE?

SCHWARTZ: No, at that time...

NORBERG: Was it still on JOVIAL?

SCHWARTZ: Oh yes, that is right. We were getting criticized for some of the work we had delivered to the 465L project in Omaha. I took over the maintenance of the compilers that we had developed for Omaha.

NORBERG: Yes.

SCHWARTZ: So I was doing that job for some period of time, from that point when I got back until I got involved with time-sharing systems -- at least as far as I can remember.

NORBERG: When do you first remember Licklider showing up out here in California?

SCHWARTZ: I remember that there was a meeting at SDC, but boy, dates... It was probably the first time I met him. McCarthy was there; I remember Corbato was there, and a variety of others of those days. I got to meet those people at that time. That was where I first heard time sharing discussed. I will guess then, that it must have been in 1962. I don't remember what part of the year, but I remember that at that time I knew almost nothing about time sharing, and of all the talks the one talk that I really absorbed was one by Corbato. He talked about something he had delivered in a paper about their original time sharing work at MIT with a three-user system, on the IBM something -- the 709 probably. And I began to understand the concept of time sharing at that point although time-sharing and my understanding were limited at that time. That was from where many of my ideas came. That was when I first got to know Licklider and those people. I would guess it was at the end of 1962, or it would be some time in 1962 and not 1963.

NORBERG: That makes sense, because in a paper that you, and Coffman and Weissman published in 1964, the spring Joint Computer Conference, I quote, "Since June 1963, a time-sharing system has been operational at System Development Corporation of Santa Monica. This system was produced under the sponsorship of ARPA and has utilized ideas developed at both MIT, and BBN, as well as some original techniques by June 1963." Now what I recall, and I am sorry I didn't bring these notes with me, reading in ARPA records from this period is that there were two advisory committees set up, and I am trying to remember the distinction between the two. One of them had McCarthy, Corbato, and a couple of representatives from SDC on it. I can't remember who the representatives were on the other one, but it is the other one that I am interested in, because you were on the other one. These two groups were set up as technical advisory groups to this project. I suspect that that was Licklider's doing at the end of 1962, early 1963 or so.

SCHWARTZ: Oh, I am sure it was.

NORBERG: Right. Now, Fredkin came out as some sort of consultant for awhile.

SCHWARTZ: Yes. We did not hit it off.

NORBERG: Well, let's leave that aside for a moment. Let me try to get the details here. Following the meeting you just described, what did you do next -- you and your people? Tell me who the project people were working with you at the time.

SCHWARTZ: It changed over time, of course. But the people I remember who were important were Clark Weissman, Ed Coffman, Art Rosenberg, a few programmers -- Alex Tschekaloff was one; people who have scattered since then -- a fellow by the name of John Hodgson. There was a team of six or seven people, another guy by the name of Clay Fox -- but I have a feeling that he came later.

NORBERG: Yes. And what exactly was this group to do?

SCHWARTZ: The charter was to produce something usable by the outside world in about six months...

TAPE 1/SIDE 2

NORBERG: What did it mean to do something for the outside world?

SCHWARTZ: Well, to produce a system that could be used by members of this group or the scientific community: Stanford, Berkeley; SRI was involved in those days; maybe UCLA, although they might have come in later. I do not know, perhaps there were others.

*Revised 2012-02-11 to correct spelling of Ed Coffman and Alex Tschekaloff, pp.14, 15.

NORBERG: You are talking about a West Coast community then?

SCHWARTZ: Yes. I cannot remember if any Carnegie people were there, other than Perlis, who was in some of these meetings. (I do not know about the two groups.) The purpose was to produce some kind of system -- a time-shared system -- for a community of users.

NORBERG: Okay. What did you people see as the nature of the problem to be solved? What is it you felt you had to do to achieve this objective?

SCHWARTZ: Well, let's say we needed to provide a capability for other people to program, and debug programs of any kind using a variety of languages. In other words, we did not make it a FORTRAN or ALGOL based system, did not orient it to a specific system. We provided an on-line debugging capability, which was similar to what DEC had developed, or was developing at that time --the DDT system. I cannot quite remember if it was running yet. Our system had some of the capabilities of access that we knew of from Corbato's system, that scheduled so you would get a reasonable response time. But the main purpose was stated in that paper we wrote which was called "The General Purpose Time-sharing System". JOVIAL had been intended to be a general purpose language in the sense it was not for mathematics, or just for systems. It could do either job -- operations or applications. That was the purpose here too, not to limit the use, but to provide a general set of capabilities. We really did not know who the user community was or what they wanted. We provided this capability, a couple of languages, and on-line debugging. So that was, I guess, what our major object was, not to limit what you could do with the system other than limitations of space, time, and things like that.

NORBERG: Well, how did this system compare, then, with the other systems that were being developed the same time, such as CTSS in Cambridge, and the early Project MAC time-sharing system. I do not want to go to Multics, because that was a different problem.

SCHWARTZ: That was.

NORBERG: But do you recall how these compared?

SCHWARTZ: I am trying to remember what CTSS provided in comparison with ours. I cannot say. I think we met our objective of providing a very general capability quite well. I had the feeling that we were better at that -- along with on-line debugging and some other things -- than some of these other systems, at least in those early months. We were limited. Originally we were using Model 28 teletypes, as I recall. Then there was the Model 33TTV. Eventually we also began to use CRTs. We were obviously somewhat hampered by response time, but nevertheless, we did do some interesting work on it. We had a great variety of applications of various kinds running under time sharing -- a large number from the education world, the psychology world, bargaining and negotiations, programming of various things, display research. We played with a horizontally displayed Rand tablet on the time-sharing system, which I gathered, display-wise, was not very practical, but it did work. So I felt that in that way we were at least as good, or better than the systems that were coming around at that time. Our problems at times were reliability and response time. Of course we were limited by the computer, since at this time we had no disks. So files were on tapes, things like that.

NORBERG: There was a fairly substantial body of Q32 users though, as I recall. Isn't that true?

SCHWARTZ: At that time?

NORBERG: Yes. You know, say 1963, 1964.

SCHWARTZ: Oh yes. Although the vast majority of real usage was done by SDCers at SDC. A number of papers were written in other areas, as far as I know, such as Jerry Shure's work on bargaining and negotiations, and a variety of others on education -- Silberman, Harry Silberman, for example -- who are now at UCLA. Most of the usage from outside, such as from people like Feigenbaum and McCarthy, was made to make me die at a young age, I think. They were quite critical of the system. I am not sure if their motives were exactly pure, but nevertheless they had legitimate

criticisms. We had been under the gun to get a system up in a hurry, and of course, when we do that we tend to make mistakes, or make a system that is not quite reliable. The one thing we did, which you probably do not hear about (or maybe you do, I do not know; you have looked into a lot of things), is we formed a network with SRI and some place on the East Coast, I believe (I don't remember where). In any case, that happened to be about the time the SRI came up with the idea of a mouse (Doug Englehardt -- who was another one around there). The network preceded the ARPA network and actually ran and demonstrated that if you have a network you could use computers the way they were eventually used in the ARPA network.

NORBERG: I seem to recall there was a link here first, though, between Santa Monica and some place in the greater Los Angeles area.

SCHWARTZ: Yes. Well, was it UCLA? I am trying to remember. I cannot help thinking there were three nodes involved...

NORBERG: It could be, but I had the idea it was in this general area before it went up the coast.

SCHWARTZ: It could be, but I cannot remember who else it was.

NORBERG: I have that written somewhere, and I am sorry now I cannot remember the details of it.

SCHWARTZ: There is probably some paper that says it. I remember SRI because Doug Englehardt was doing some kind of editing at the time. That was who it was, who stands out in my mind. Clark Weissmann, I think, was quite active in those days. He got more and more active as the years went on. He might remember some of those people.

NORBERG: Does any of this now make you recall those meetings at the end of 1962 somewhat better? There was, as I remember the records, a request of SDC to run some sort of time sharing symposium at the end of 1962 or early 1963. I cannot remember now which... Many people were invited from outside. Then there were these advisory groups

that came in. And then Fredkin came in as a consultant, and so on. All of that seemed to have occurred within six or eight months of each other. Do you recall any of the interactions, then, with people other than SDC people?

SCHWARTZ: Well, I certainly remember my interactions with Fredkin.

NORBERG: Yes. What did Fredkin come out here to do?

SCHWARTZ: He was sent out by Licklider to consult and help us get a system up. Fredkin is probably a genius. In fact, over the last 30 years he has become quite well known, and has come up with many good ideas. He is a very creative fellow. But at the time I was under great pressure to get something up. He had far-reaching ideas, such as 50 millisecond response time to a hundred or more simultaneous users, or something of this sort. I had a picture in mind, and I was trying to accomplish that before we went on to bigger things. All I remember is that every day I would come in the office early in the morning and he was there putting pressure on me to get single character responses. In those days on that computer that seemed like quite a problem, in my mind. So I finally said, "We cannot work together." I had a feeling that it could have been disastrous, because Licklider felt very strongly about his work, but he did not react badly. I always felt that Fredkin is a brilliant person, but on that particular issue, my body could not stand so much pressure. So anyway, he got out of it at that time. Other than occasionally. He did not come and consult every day he had done. So I remember that. I remember meetings. The guy who always came through to me as the most coherent and most reasonable to discuss things with was Corbato. The others, like McCarthy, and Feigenbaum, obviously were very good. There is nothing wrong with being academic, but they always gave me the feeling they were much more academic, and Corbato was more likely to get something done at the time. And I tend to be more that kind of guy than an academic. It is just the way I am. I have always been that way; I have got to deliver something. Now I remember getting many criticisms on our system at those meetings. Of course, I also heard what was going at that time on from others at those meetings. What was going on at Stanford. Butler Lampson was another young fellow -- young at the time. He was developing some interesting things up at Berkeley. He stands out in my mind because those days were the beginnings of long hair and sloppy dress days, and he used to come in with a suit and tie and a short haircut, which was unusual for a college student. He might have been an undergraduate. He

may have been a graduate; I do not remember. People from BBN would talk about what they were doing. That is basically what I remember.

NORBERG: What sort of meetings are you talking about now? That sounds like the PI meetings that ARPA began to run.

SCHWARTZ: Every six months?

NORBERG: Yes.

SCHWARTZ: Yes. Are you talking about those very early sessions like at SDC? Other than criticize what we were doing, I cannot remember very much. We, of course, told people what we had planned. I am trying to think of details. Perlis used to be at a number of those things and was an interesting person to listen to. But I tell you, I have a hard time remembering what was going on. I remember hearing what McCarthy was doing. Was he working on developing a system on the PDP at that time? Berkeley was doing something...

NORBERG: Part of PDP was (?) at Berkeley. Did you ever have a one-on-one conversation with Licklider?

SCHWARTZ: Probably some in the early days, but when I look back I cannot remember very many. The guy I talked to more was his replacement, which was Bob Taylor and Larry Roberts. I remember them a lot more.

NORBERG: Okay, tell me about Taylor who came in in early 1965, I guess, and then became director of this new office, IPTO, in the middle of 1965. What do you remember about your association with Taylor? Then I will come back to this other question again.

SCHWARTZ: Well, he was a much less academically -oriented guy than Licklider or any of the others we had been associated with. I cannot remember what his background was, but he was one of the few that did not seem to have a

very strong technical background. He was a generally interesting guy to talk to in the sense that... In some ways I am more like him than I was like McCarthy, or Licklider even. He wanted to get things done. As I recall, it was during his stay when the idea of trying to get more involved with the applications of research was coming around. Somehow, as I recall, the Rome Air Development Center began to interact. And, as I keep saying here, I tend to be that kind of person -- not a basic researcher. So, during that period we were proposing a lot of application or applied research. The basic time sharing at that time was not changing very much. So the biggest thing that was going on at SDC (I have one hesitation here...) was funding other projects that were using the time-sharing system, such as Data Base Management Systems. One was called TDMS -- it was an inverted file system. There was a display system we had called GPDS; I guess ARPA funded part of some of that, which was a general purpose display system. That horizontal-Rand tablet. Some work was being done in the education and psychological areas. It seemed to me a lot of that was coming around during Taylor's time. That was more the sort of thing that was happening rather than any major advances in time sharing. By that time I do not recall what we were doing in time sharing per se other than improving scheduling and reliability. One thing that I am hesitating about is that at some point we began an effort on the IBM 360/50.

NORBERG: It could have been. But that would be late 1960s.

SCHWARTZ: Yes, well maybe it was later then. As I remember, Clay Fox was involved with that one. Anyway, that is basically what I remember. I remember making proposals with another person on the SDC side, Bill Barancik, who worked for the Research and Technology Director. He would talk to Taylor at great length about ideas and put proposals in.

NORBERG: How would you contrast Taylor with Licklider in terms of their approaches to contractors?

SCHWARTZ: Well, he was less a dreamer, I would say. You know, he was basically more a nuts-and-bolts kind of guy. Licklider was a conceptualizer. As I recall, Licklider had a pretty violent temper. I guess, before I got involved, Paul Greenberg was getting hammered by Licklider for the kind of research he was or was not proposing or doing at

the time. That is when the time sharing thing came up. Taylor was easier to talk to, to my mind, with more concreteness. Now that I think back, other than at meetings on occasion, it seemed to me that Licklider and I always got along pretty well. I never had anything directly against him. Some of his people used to give me a hard time, but I always liked him as an idea man, and as a guy who supported us. He did support us during that period on the time sharing part of it. There was nothing wrong with him. It is just that he was different.

NORBERG: Yes, I was not looking for that in my question anyway. Let me ask the question somewhat differently and try to look at it from the SDC perspective. What do you think SDC's strengths were in that period of the early 1960s when it comes to computer developments?

SCHWARTZ: At that time many of the people we had working in that particular department at SDC were what I would call "good programmers". There were very few programmers that had gone very far in a university computer-wise -- very few Ph.D.s on the programming side. There were a number of Ph.D.s on the psychology side. It was people who were the kind who, when given a job to do, would work quite hard, in general, to get it done, but they were not great creators. There were some, but not anywhere near the number of conceptualizers that you would find out in the universities. Clark Weissmann tended to think more that way.

NORBERG: But that emphasizes their weaknesses, not their strengths.

SCHWARTZ: Yes.

NORBERG: So how about emphasizing their strengths?

SCHWARTZ: Their strengths were the ability to do a job, to get a job done in a rather short deadline, to organize things reasonably well, to turn out reasonably good programs in a short period of time, to learn new concepts once they came about. This was the programming side. Now there was a whole other group that was involved. In fact, many of those who were not that kind of people, I guess, actually worked for me. I mean, they were conceptualizers

in their fields, which was not time sharing per se. It was the use of time sharing as it applied to their fields -- and that is mainly people with psychology backgrounds, who were at SDC because they were originally part of the major SAGE training program. They had a lot of graduate psychologists doing this program. They became active in the education field (also the language translation and information retrieval fields -- Bob Simmons, who is now, or has been at the University of Texas, did a lot of work on that system). As far as data processing, though, for the most part they were people with university backgrounds, probably in math or similar subjects, who were good at producing programs when asked to do that. Not that they were impossible at creative things, but they were not "What's 20 years down the line going to be?" kind of people.

NORBERG: Okay. Now, if that is the case, if that is an adequate description of the strengths of SDC, is it fair to conclude that maybe people like Licklider were asking too much of an organization?

SCHWARTZ: Well, I guess it depends. I do not think so. First of all, we could understand -- or at that time we started understanding -- many of the concepts that were used: what we were trying to achieve with a group of people simultaneously accessing a computer, what some of the scheduling problems were within the computer, and we had enough engineering help to understand how to attach the terminals, both from outside as well as inside in those days. We had some communications help from DEC, and a little bit from BBN, I guess. And some of us had a certain amount of creativity, up to a point, where we could think and expand on a concept reasonably well. So if you wanted a job that handled many of the currently known concepts demonstrably within six months or a year, it seems that that kind of group was a good group to use. For example, one of the things that I always felt was a problem with Multics, which came later, was they originally had plans to get something done, as I recall, in a year or two. They certainly had a group that was, I would say, IQ-wise and education-wise, much higher than the level (and also, they had numbers at that time) than we had at SDC.

NORBERG: Numbers meaning a larger group of people.

SCHWARTZ: As I recall, they had a fair-sized group between MIT and GE working on the Multics time sharing

itself. That was a harder job. Sometimes, I think, it began as a case of not that many people, but that many great brains. It is very hard to say, "All right, we're going to cut out this concept and show it to the world over the next year." The world learned a lot from that, but our objective was always to try to get something that the world could apply within the next year or less. For that kind of job, I think SDC was a reasonable choice. There were enough good brains and enough people around to apply the system to other applications than to just straight program development. That made SDC a reasonable place to do it. So I would say that what you said was not necessarily true.

NORBERG: All right, let me quote to you something else which I am puzzled about. There are a number of reports in various places -- I cannot remember whether it is in Baum's history of SDC [*The System Builders*] or not, but it certainly is commented on in other descriptions of the ARPA activity at the time -- that there was a conflict between Licklider's office (whatever that means) and SDC on exactly what sort of objectives were going to be achieved. Licklider seems, and has said, that he feels that SDC was going too slow. Let's see, how did he phrase it now? I am trying to think of published things, not things that he might have said privately. He said that he was concerned about the inability of the SDC people to appreciate the larger picture associated with the problem. Now, the way I interpret that is that there is a difference between that group of academics in Cambridge -- now I want to leave McCarthy and Feigenbaum out of this -- that saw themselves as pushing the frontier of a field, and still believe that they did (whether they did or not we'll talk about later. But they still believe that they did), and a group of people that Licklider had inherited from the Air Force Office of Scientific Research and Development, or whatever the proper name is, and various other Air Force activities, who were not in the business of pushing the frontiers of a field, but were in the business of creating a product of use to the military, which is essentially what you just described.

SCHWARTZ: Right.

NORBERG: Well then, how did this discontent, maybe even hostility, show itself on the part of Licklider when he came to visit? From what you said it did not show itself at all.

SCHWARTZ: Not very much with respect to the time sharing effort. He did not defend us very much when we got critiqued or criticized by users, such as McCarthy and others, and Feigenbaum. I guess he might have taken it that we had not done everything we could have done in the time. But on the other hand, we were producing a system in a much shorter time than others. I feel that in some sense some of the criticism was unjustified. We did have a working system. I am trying to think. He was violently against the operation that Greenberg had run prior to when I came in. Greenberg was almost pushed aside, as I recall. I forget what his role was, because Licklider then focused on us getting the time sharing out, which was his ambition. When did he make those statements? Because I can understand that he was very critical of all the research that was going on prior to that. We then had time sharing which was, let's face it, maybe six to ten people out of the total ARPA contract at that time. I can not remember -- maybe 12 people, or something like that.

NORBERG: Well, the Barber study, for example, on the history of ARPA, which came out in 1975, has some statements in it from him.

SCHWARTZ: Do you know when they were made?

NORBERG: Oh, yes, around that time -- 1974, 1975.

SCHWARTZ: 1975?

NORBERG: Yes. Then he has made some of the same comments to us.

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NORBERG: You are making a distinction, I think, between the time sharing activity and the range of other projects that might or might not have been funded by ARPA at the same time.

SCHWARTZ: Yes.

NORBERG: There was a rather major contract some time in 1962 to keep the Q32 involved in various activities, and that became part of the time sharing, or time sharing became part of that afterwards. Is it possible that any of the problems that you are alluding to, and others that have also been mentioned, come about because the Q32 was not really the right machine to do this with anyway?

SCHWARTZ: That is quite possible. That was what we had. It was, at the time, as fast as most other computers that were available. It had its limitations. What did we have? We had a drum, and tapes, and a limited memory. We stuck a PDP-1 on the front end for communications with teletypes -- certainly, when you look at today's computers, it certainly was limited.

NORBERG: Yes, I do not mean to make that comparison certainly.

SCHWARTZ: At that time it certainly was adequate to demonstrate a concept. What you could expect from it is another matter. I mean, memory size was limited (although large for those days), so obviously there was a lot of swapping going on and restriction on program size. At the time it was a system to demonstrate the possibility of doing these things, and as hardware improved you could expand on it.

NORBERG: Did you know the 709 well enough to make a comparison between those two machines, after what was going on at MIT?

SCHWARTZ: Well, I had worked on the 709. That was where the first JOVIAL compilers were.

NORBERG: So you do know about that.

SCHWARTZ: Yes.

NORBERG: Would they have had an easier time solving some of the time sharing problems using the 709 than you people had with the Q32?

SCHWARTZ: I do not think so. I cannot remember when disks came in. I guess we eventually got disks on the Q32 at some point, now that I think about it, because we used them for data base activity at some point. So we did get disks, but I do not know when that was. I do not think that the 709 would have been any better. The Q32 probably was better with character handling, and it was probably faster than the 709. The 7090 was probably better, but the Q32 had some other advantages, like byte manipulation and some other things that made the machine language program a little more powerful than the 709 series. So, I mean, given the environment at the time, you cannot expect too much to get done, but on the other hand, with what was immediately available, it was probably satisfactory.

NORBERG: During this period, 1962 to 1964, did you ever go to MIT? Not Lincoln now, but MIT.

SCHWARTZ: I am sure I did. I remember being out there. There were probably meetings out there.

NORBERG: None of them stand out?

SCHWARTZ: No more than any of the others.

NORBERG: All right. What sorts of projects then developed after this time sharing activity on the Q32?

SCHWARTZ: Well of course, until I left SDC, from once we had a time-sharing system working -- other than changing hardware (I guess now that I think about adding discs, and I cannot remember when that was), and adding terminals, things like that -- the main thing was adding new applications and an interpretive language called TINT, which was similar...

NORBERG: T-I-N-T?

SCHWARTZ: Yes. ... which was similar to JOSS, which we did spend time on at Rand, who was also involved in those days. Cliff Shaw, for one. A number of these applications, such as information retrieval, database management, also education. Our proposals tended to be in those areas: also natural language understanding and a variety of others. That was what went on until I left SDC in 1969.

NORBERG: 1969. Were most of these funded through ARPA?

SCHWARTZ: Much of it was, but not all of it. Some of it -- a fair amount -- was independent research funds.

NORBERG: Independent, meaning what?

SCHWARTZ: IR&D funds. From, you know when...

NORBERG: From DOD?

SCHWARTZ: I guess it was DOD. When you are a government contractor, depending on the kind of government contractor, you either get 100% or partial funding towards a research program which they review periodically. It is sort of like ARPA, but it is a little less controlled than the ARPA was, I would say. I think CSC now has some of that performed by the more government-oriented groups of the company. In fact, I know they do. I have seen their IR&D reports. So that was funded. There was some funding from various places, like RADC. ONR, as I recall, gave a little money to some of these researchers. I don't know who else. There were probably a couple of other small ones. ARPA was part of the funding.

NORBERG: Then did you have any significant interchange with Taylor and Roberts after Licklider was gone? You talked a little about Taylor.

SCHWARTZ: Well, with Roberts, yes.

NORBERG: Did Taylor try and get networking started when you were at SDC.

SCHWARTZ: Now, I am trying to remember that too. Wasn't there a period when Roberts and Taylor were together?

NORBERG: Yes, Roberts was hired by Taylor, or by ARPA, to oversee network development as a special program.

So he was a scientific consultant in the office before he took over.

SCHWARTZ: Well that is right, because I vaguely recall working with Roberts on the networking stuff. But Taylor was still there.

NORBERG: That would have been during 1967, because Roberts showed up at Christmastime of 1966.

SCHWARTZ: So that, of course, as you say, always continued to be. That was the beginning of the ARPA network idea, and our networking concepts with SRI. I guess we dealt with them on our own research, and getting, of course, renewals of the ARPA contract.

NORBERG: Were those significant renewals, in terms of money now?

SCHWARTZ: They probably were going down, were they not, towards...?

NORBERG: They were decidedly going down, but that is as compared to six million for setting up the computer lab that SDC organized around the Q32.

SCHWARTZ: It seemed to get harder over the years.

NORBERG: Do you remember when the Q32 lab was closed down?

SCHWARTZ: No, I was gone. I just know we probably had to fight harder and plan better. Barancik was a very good help in preparing proposals and helping to actually deal directly with these guys on contract matters, and getting new contracts.

NORBERG: What do you think was the problem in getting new contracts?

SCHWARTZ: Well, first of all the competition got severe as the years went on. SDC was one of the few non-university groups, which, I think, does not help in an atmosphere like that. I do not know what percentage of ARPA funding went to universities as opposed to corporations, but I always had the feeling that being non-university, and being the kind of people that we tended to be, which I have described, even though we could turn out reasonably good work when required, and had some researchers on the side to create new concepts, we always were at somewhat of a disadvantage in conceptualizing 20 years-away-work (or 10 years) -- we were just not able to compete very well. I know I am not.

NORBERG: But at least the records indicate that toward the end of the 1960s, there was a period in which there was a greater determination to meet military, or DOD mission objectives using ARPA projects, or any projects across the Department of Defense. This, it seems to me, should have played more into the hands of a corporation like SDC than it would into the hands of somebody like MIT.

SCHWARTZ: I do not know how much that helped us. There were certain areas, I think, in which we actually did some very good pioneering work such as database work. That was sponsored, as I recall, by ARPA to a large extent.

NORBERG: Can you describe that?

SCHWARTZ: Yes. In those days in the 1960s, the concept of a database was really, as far as I could tell, of very little or no interest to the universities, who were very good at many things. But we, the people at SDC, had come up with these ideas of putting large amounts of this commercial or military-oriented data away and retrieving it quickly with English language type queries. There was an old prototype system called LUCID, which ran on the time-sharing system (I believe). Then there was TDMS, which was a major development on the time-sharing system, one of the first Data Base Management Systems, as far as I know, in the world. TDMS eventually became the property of MRI in Texas, who for many years sold a new development of it commercially called Systems 2000 as a major database system. The concept was based on TDMS. Of course, they improved it. That system was of great interest to the military and I know in the Pentagon they actually tried using it. I forget what kinds of results we had. It was quite limited at the time. It demonstrated some concepts again and these concepts have been used over the years quite a bit. Adabas is a system which has utilized some of the concepts since they started in the late 1960s.

NORBERG: Which base was that?

SCHWARTZ: Adabas, developed by Software AG, which was (and is) a German company.

NORBERG: How is that spelled?

SCHWARTZ: A-d-a-b-a-s. It is a database management system. Software AG now has a branch in America.

NORBERG: Yes.

SCHWARTZ: I do not know how much they got from us, but certainly MRI got the system. Other people took the system.

NORBERG: Can you go back to describe for me how the system developed and what SDC's role in it was? Because this was praised quite substantially by the ARPA director before Congress as one of the major applications of time

sharing and ARPA's activities in information processing with military objectives.

SCHWARTZ: Well, actually it got started by a single individual by the name of Emery Franks. This must have been the very early 1960s... Emery began the work even before he had the time-sharing system available. He developed a system called LUCID, which basically operated on the idea that you would, in effect, not keep databases in just plain record form so you would have to look for records, but you could pull out every element of the record and sort it. So when a question is asked, such as is element one greater than three and speed less than two and air pressure greater than twenty-three?, you could immediately find the records that correspond. The technical problem with that was, to update a database and update all of these different sorted files was a major time concern, which TDMS or LUCID did not solve in the time period. TDMS was an expansion on LUCID, which was very preliminary, with a bigger team headed by a fellow by the name of Al Vorhaus.

NORBERG: Vorhaus?

SCHWARTZ: Vorhaus. V-O-R-H-A-U-S. It was a much more comprehensive version of that original small effort, and it ran on the time-sharing system. It was demonstrated from many places. Many talks and papers were given. Interestingly enough, at that time the rest of the ARPA community, as far as I can recall, had no work in that area, and did not even express interest in it. They were doing other interesting things. So that is what it was. It did not solve many problems that made it really feasible or practical. But people at MRI in Texas liked this, and they took it and made changes, which made it practical, too. For quite awhile they made money. I do not know where they ended up.

NORBERG: Would you be willing to agree that one of the differences here between the universities not being interested in database management systems in the 1960s, and somebody like the military being interested in these is basically summed up in the individuality of the activities of the researchers in the university, such that if I am doing research at USC, I am constructing my own database that I am going to manipulate, and I do not need you to tell me how to construct that database, because I am using it for a very specific research purpose. When the research purpose is ended, out go my personal files anyway. So I am not going to try to build this into something that you

then can use. On the other hand, these people are simultaneously talking about developing a network where I can get access to your files, and load them into mine, and use them as I see fit. Now my question (which now seems to be a little convoluted, so let me restate it) is first of all, would you agree that there is that difference between the university researcher building his or her own data files versus somebody who is trying to build a system that Mr. X can use in another environment? Is that an adequate distinction between the two?

SCHWARTZ: Yes. I think that is one distinction. I think there is another one which is that university people had some advantage -- whether it was because of their reputation or because of their environment, I am not sure. But during the period that we were developing these things, under great pressure to have them available for other people, we would hear reports on what was going on at Stanford and other places. A good example was the ILLIAC IV project, which is a different kind of project. Every year you would go to the conferences and hear that the schedule had changed; they were still evolving new ideas, but they were not really producing a system in the time period they discussed for use by the world. We got much more static as people tried to provide a system that other people were presumably depending on, whether they were or not, than they did. So they were much less under this pressure of, "If you don't have it in six months, out the door." So I think that is another way to make a distinction. They were able to develop their own files and their own concept with their own students in a fairly close environment without some of the pressure that people like us tended to get. (I'm not sure I answered your question.)

NORBERG: Yes. Let's go back to the second question that evolved as I was asking the first one, and that is, is there a difference between this idea on the part of the university people that they wanted to build a network such that one could get access to the files of another and transfer them wholesale and the attempt to develop a database management system of the kind you describe for use by others? That just becomes a common file, as far as I am concerned. It becomes a common file to which everyone can dip into for whatever purposes. What are the differences between those two?

SCHWARTZ: Well, okay. It is hard to answer that exactly. What we were developing with this concept were programs which provided the capability of building any kind of database in a way that would make any kind of

database available to the user in a very friendly and fast way. So were not developing databases, per se. We were developing concepts and programs which would enable anybody anywhere to develop databases and access them. I could be wrong, but I cannot remember any of the university people ever playing with, or trying that particular tool. We did have a lot of interest from the military for demonstration purposes, and industry came in a lot to look at it. What I am saying is that that concept which normally wasn't considered was grown at the company.

NORBERG: Building a system like TDMS requires a network, does it not?

SCHWARTZ: No, not really. You need a moderately large computer and a large disk. The purpose is to be able to ask queries. You would not want to build TDMS in a batch environment. So you do need a terminal. In that sense you need a network.

NORBERG: Yes. But that is just a basic time-sharing system as opposed to a network. What I conclude from that, then, is that the objectives diverge between what you people were doing, or were being asked to do by the various groups in the Department of Defense and elsewhere, and what was going on inside the IPTO office, which had pushed itself in the directions, first of time sharing, and then of networking. I am interested in that period -- the 1960s, now. I am not trying to go beyond that, where the things get structured into five separate programs.

SCHWARTZ: That is certainly true. Once BBN got the ARPA network contract which we had tried to get. I guess, as I recall thinking back a bit, we did not try hard enough. But we may not have won in any case. It is true that that was a very significant point, whether I felt it at the time or not. Of course, at that time other things such as flat screens, artificial intelligence (e.g. ping-pong playing) and some of the other things going on were of much general interest. We were not doing much in those areas, although we were doing some language work. So, yes, I guess that is true. We were having a harder time saying, "Is this what you want, ARPA?" At that time I left -- the late 1960s. I did not leave for that reason.

NORBERG: I will come back to that. Were there discussions inside SDC among you people managing projects about

the directions ARPA was taking at this time? Maybe I should ask the question a different way. What was the contracting procedure like at the time? How did you develop a proposal inside SDC? How did you approach the DOD? How was this accepted at ARPA, and what negotiations went on after that?

SCHWARTZ: You know, I tend to be a person who will respond to those problems of proposals and things when asked to do a specific thing. I am not a very good guy to say, "I need to go get business this year, so I am going to sit here and plan, how is the best way to get business." I can say that I know that I have some things going on -- database, and time sharing -- and I have some other researchers who are doing language work, or whatever. They can make their proposals. But the guy that at that time organized that sort of thing and saw to it that we come up with pricing something, and negotiated really hard, other than on some technical matters, was Bill Barancik. I cannot quite remember. In my directorate at that time with all our researchers we peaked at around 120 people, which included a number of people in areas that I was not that technically well-versed in. We would have things going in those areas, and occasionally somebody would come up with a new idea, which we would ask them to expound on, or expand on. Barancik and I would present these ideas. As I recall, for the most part we would sit and put these packages together, and carry it out to whomever the ARPA guy was -- Taylor or Roberts. The funny thing is I can hardly remember doing that with Licklider. When did he leave?

NORBERG: 1965, late 1965.

SCHWARTZ: I am not even sure that I was that directly involved with the contract man up until that time. I was much more involved with Taylor and Roberts. But usually, as far as getting a contract with a guy like Barancik, who eventually went out on business on his own...

NORBERG: That is a fair description, though, of what would be going on -- where there would be discussions inside SDC about things that might be proposed, and then discussions with whoever, Taylor, say, which then might encourage Taylor to say, "Well, send in a proposal." What I saw in the ARPA records were a significant number of proposals from SDC over the years of the 1960s. Often they were continuations of the time sharing applications that

you described. Those were all there, and there were often requests from others, such as Uncapher, whom I distinctly remember now as asking if he could get access to the SDC computer with a line, and would they give him a terminal for his office. I have forgotten where it was; it might have been at Rand. It was granted under the contract, as more money was supplied, and so on. I think that that is right. I think it was between SDC and Rand, but I did not say that at the time because I was not sure either. There are a number of those requests in the files. There were quite a number of proposals as well. They were all continuations of an earlier contract, basically, which had been the original contract for setting up the Q32 anyway. Therefore, what you have described is what I understand is the typical process going on in ARPA, at least in the information processing area, where a large number of contracts were the result of the kind of conversations that you are talking about. Now, there is a difference, it seems, in what I am going to call the styles of the IPTO directors, starting with Licklider on. There is a difference in style as to how that is done, as to how aggressive the person running that office is, and going out and finding out exactly what you are doing, and how it can be pushed further. I can see where that could develop certain kinds of personal problems if the aggression on one part is too great. So the contracting procedure you have described seems to be consistent with what other people were experiencing. What was the effectiveness of such conversations? For every ten conversations, did you get one contract, or five contracts, or all of them, maybe?

SCHWARTZ: Five individual projects funded, is that what you mean?

NORBERG: Yes, added on to the original tasks. Success rate, I guess, is the way it would be described.

SCHWARTZ: I cannot say. For most of those years our staff stayed approximately the same size. It probably grew some for awhile and began to cut back towards the end of the 1960s. But of course, the funding came from several sources. And I do not remember any major...

TAPE 2/SIDE 2

NORBERG: So you said you guessed that the network competition with BBN was a disappointment.

SCHWARTZ: Yes, that was. I recall, now that we sit here, sitting in a conference room several times... I think several times... with visits by, probably Taylor, probably Roberts, where individuals would get up and talk about the current projects which they were trying to extend, or plans for new projects.

NORBERG: This is all within SDC?

SCHWARTZ: Yes, I can remember where they would come out. I can almost visualize the conference rooms now. I don't recall many new things -- any major new things -- getting funded, particularly after the mid-1960s. Whether we were not coming up with very good ideas, or they were just not going to fund us, I do not know. Many of the old projects continued funding in some form or another. Maybe they got cut back some, but again, it gets confusing because we had IR&D funds, which might have helped somewhat. I tell you, a guy like Barancik, who is more an administrative type, would probably be able to answer the kind of thing you are asking now better than I. I tended to be more interested in the management of what was going on technically, just keeping an eye on that, particularly in certain areas, because in some other areas I was not able to suggest very much.

NORBERG: Sure. All right, you said that in 1969 you left SDC...

SCHWARTZ: Yes.

NORBERG: What occasioned the desire to leave?

SCHWARTZ: SDC had been a non-profit company for many years, the whole time I was there. At some point, probably around 1967 -- sometime in there, maybe even in 1966 -- SDC decided that they really should go profit-making. For several years, that seemed to be the major goal of the company. It seemed to me that it was swamping everything else. The company was getting uncomfortable, at least as far as I was concerned.

NORBERG: Uncomfortable in what sense?

SCHWARTZ: Well, I felt that they were devoting so much energy and interest technically and other ways, in just this problem of going profit-making that they were not supporting some of the other efforts, such as those that I was in, at least psychologically, if no other way. Most of the time we were on our own on this. There was very little direct influence from corporate management. And it got worse during this period. What was happening was that during that period, SDC was trying to sell itself, and it would get a variety of business people -- presidents, or chairmen of boards, or groups to come in to review the company and its prospects and its people. As a result of that, although nobody, at least up to that point, decided they wanted to buy SDC, or SDC did not agree with them -- whatever the reason -- they approached some of us as individuals. I personally was approached by two different people, one as an individual. That was John Reed, who is now chairman of the board of Citicorp (at that time he was third vice president or something of Citicorp), which was just forming a force that eventually became TTI, I guess. At that time, it wasn't yet formed. TTI was to be his commercial network implementator, I guess. He gave an excellent offer, but I decided not to accept his offer, because, at the time, it would have meant moving to New York (which he would have changed later). But another person came and talked to a group of us, and convinced us that he wanted to set up a growing computer company, with four or five of us as the nucleus of it, and offered us big money and a big office and all that. If I look at mistakes in my life, taking him up on that offer was one of them. He was John King. He was the youngest man ever elected to the State Senate of Colorado. He was Nixon's Olympics representative in Japan. He was going up to be a billionaire. His business in Denver was King Resources, and they were selling shares in oil. You know, one of those...

NORBERG: Yes.

SCHWARTZ: He formed this company, consisting of the five of us, plus some others that we took along, and set up an office here in West Los Angeles. But after a year or so it became obvious that this was not the right thing to do. Then I went to CSC.

NORBERG: Yes. I would say that CSC is not much different than the SDC you described at the end of your tenure there, in terms of trying to sell itself, being out there gathering business in a very legitimate way -- but thinking of itself as a profit-making business enterprise, not as a service organization in any way. Now, did you see this in 1970 when you were thinking about coming here, and how did you feel that it would be different here than it was at SDC?

SCHWARTZ: Oh, well, it was different. In a non-profit world, if there is a lot of research and a lot of interesting work, there is a certain incentive. And if the management is supportive, you really feel there is a technical objective. I had a long history with Wes Melahn, who became president of SDC. He was my original boss at Rand Corporation when I was brand-new in this business. I really found I enjoyed working with some others more than him. He was also a very intelligent man, but charisma was not one of his strong factors. So there was always this feeling that he was not a very helpful or supportive person. During those years, when he finally decided to go profit-making and concentrate every ounce of energy in that direction, it just became an uncomfortable and unpleasant environment. There is no question CSC is a very aggressive, very sales-oriented, very profit-oriented company. Making a profit at CSC was very important. I knew that, because we had competed against CSC, and I knew of them for some years. But in some ways, that was a challenging environment. I tend to get used in a fairly technical sense anyway. I am not out there marketing; I assist in marketing. They were doing a lot of work at that time in time sharing and compilers, a lot of systems work -- more than they do now. There was much more of that sort of work for companies like CSC from places like IBM and other manufacturers in the late 1960s and early 1970s -- probably the early 1960s for CSC than there is now. Although not much of the current CSC technical work is out here in L.A., I spend a lot of time reviewing things going on in the National Weather Service, European contracts, commercial work of a variety of kinds elsewhere in the world. I do a large variety of things.

NORBERG: Can we go back to the early 1970s though, when you came here? Were any of the contracts, or any of the projects that you worked on supported by ARPA?

SCHWARTZ: No.

NORBERG: They were not.

SCHWARTZ: I do not know if CSC has ever had work with ARPA.

NORBERG: I see. Okay, so it is outside of that whole environment. Well then, let's shift the conversation to the outside environment. Can you tell me a little about some of the specific projects that you worked on for the corporations that you mentioned specifically, which would be proprietary, perhaps, but not government classified.

SCHWARTZ: You mean, that I worked on for CSC?

NORBERG: Yes.

SCHWARTZ: Well actually, at the time CSC was doing a lot of compiler work -- some of which was JOVIAL, and other languages as well. I did not get directly involved in any of those when I first came.

NORBERG: Yes. What did you get involved in then?

SCHWARTZ: When I first came I was doing a variety of miscellaneous consulting things. One of them was an on-going contract with the Japanese -- Fujitsu, I guess -- answering questions of a variety of kinds, presumably about products. I did a lot of that sort of thing. The first things I did for CSC was a lot of miscellaneous consulting and reviewing of systems and technical parts of proposals. But CSC in those early 1970s was in rather bad shape economically. They had invested a lot of money in the Infonst time-sharing system, which was being used but still being completed. But in the early 1970s, GSA came up with the requirement to get a commercial time-sharing system for the government. This was a major contract. I had been, among other things, investigating the use of this time-sharing system for data management in a very simple way -- not the same as TDMS, but the same ideas. In fact, I delivered a paper on it in the IFIP conference in Stockholm. It was called DML at the time. It was another database accessing system over a time-sharing system. It had certain constructs that looked like the language BASIC in its

form, but it was oriented to database applications. There was another system called "Commercial Basic" which at least gave us the idea of something like this. The DB System turned out to be a very crucial part of the GSA RFP. They had to have a database management system of an advanced kind to use for the Public Bureau of Housing. That was the main initial application. Without a system like that, no one could win the contract. We had, at the time, two other systems then running that were sort of data management. We had some changes to make to meet the RFP, but it was decided that DML was the one we should bid. And in fact, it turned out to be very critical. So that was one of the first creative things I did for CSC. As I said, I delivered a paper on it in Stockholm, whenever that IFIP conference was.

NORBERG: That would be toward the middle 1970s then, when that paper was delivered.

SCHWARTZ: It must have been. It must have been at least 1974. I had been involved with other things also. I spent a lot of time in Chicago in those days working with the National Blue Cross/Blue Shield on some system. I gather they eventually used this system. I just heard that somewhere a few months ago. I had finished my part of it and left. In the late 1970s I was involved in CSC getting the Medi-Cal contract, and I managed the development of that up in Sacramento. I spend a lot of time in Europe reviewing projects and occasionally helping with them.

NORBERG: When you say reviewing projects, what exactly does that mean?

SCHWARTZ: Oh, it is a technical audit, basically. For example, the most recent one I have been involved with involved a fixed-price contract that we have, with the government in Germany.

NORBERG: The West German government, I presume.

SCHWARTZ: Yes. As a matter of fact, it is the Air Force, but it is associated with NATO. Fixed price contracts are, of course, something companies like CSC worry about. So I have been over there four or five times over the last years to see how they are doing, to see if they have had problems. What I do is say that they are not going to make

the schedule, so they had better stop this, or start that, or get rid of that. That kind of thing.

NORBERG: I see. Okay, Have you ever given any thought to the interaction between SDC and ARPA in the 1960s in terms of whether or not the ARPA concept was a good idea, or was an effective idea, or for the most part, was moving in the right directions, or whatever? I am not trying to put words in your mouth, but I am trying to see whether you have thought anything about it over the years.

SCHWARTZ: I do not know if this answers your question. When I look back on that and think of the meetings we used to attend in places like Hawaii, and out at Utah, and some other nice places, listening to what was going on, as well as telling people what we thought we were doing, I have always said, "They have sponsored some very interesting early work in many areas that today are recognized as very important, and probably will be even more so in another ten years, as the kind of work that research organizations would have been doing ten years ago".

NORBERG: Can you be more specific on that though? Which ideas?

SCHWARTZ: Well, some of the early work. Now, my problem is that technically, I have a very hard time assessing how well they do in those areas, or did, as opposed to other groups independent of ARPA doing similar work. I used to listen to the MIT people, and the Utah people also, as I recall, discuss using the early t.v. with computer, among other things, to help blind people. Whether it ever became practical, I do not know. The hardware at that time, of course, was limited. Computers were being used to play ping-pong, and other artificial intelligence work was going on, I guess, at Berkeley and Stanford -- that sort of thing. The ILLIAC IV work was good. Of course, it did not make what it was originally scheduled to make, but it was certainly interesting work. Again, in that area, whether they were doing better or worse than other commercial companies, or other research I don't know. There was some natural language translation work. Perlis always used to come up from Carnegie with a number of interesting things. Some of the work that we were saying we were doing, including the database and some other things, seemed to be stuff that might not have gotten a good start without ARPA forcing it, or supporting it. So I would say that I was impressed by the work in that way and I still am. I also see and hear today things about projects like LISP. A lot of

that kind of thing was promoted through ARPA as part of other things, and perhaps even LISP itself. They actually tried inventing a new kind of LISP on our time-sharing system for that effort. Language-wise it was not successful... it was LISP three, or LISP two, or something.

NORBERG: LISP two, I think, if I remember correctly.

SCHWARTZ: So, not everything was successful, but they managed to cull out some good brains and get a lot of interesting work started and written up. Multics, of course, and the whole concept of paging pushed IBM into the 67, which they did not, as I recall, do very well. But the concept really began in a practical way, as far as I can tell, with MIT, and some of that work that was going on with GE145 at MIT. So...

NORBERG: Yes. Can I conclude from that that what you see at least one, maybe even as *the* most important contribution of the ARPA effort in information processing is bringing together, or supporting, or both, bright people to do these various tasks?

SCHWARTZ: Yes. And describe them to the world, and make the ideas available to the world.

NORBERG: Would you go so far as to say that this was a sort of a special effort on the part of a small group of people who had nothing to do with the Department of Defense other than that they worked in this ARPA office to get these things done, which sort of makes them missionaries in a sense? I am not trying to put words in your mouth, but I am trying to push this argument as far as I can to see whether you agree with me or not.

SCHWARTZ: Okay. That certainly could be. I cannot answer that, because I never knew what pressures, if any, Licklider or Taylor were under, what direction they were under. So I never dealt beyond... There is no question a guy like Licklider was a missionary. Whether it was completely self-generated, or part of some master plan that he had, or was given, I do not know. But you certainly pictured him as a missionary, and some of the others as guys trying to put together a good program.

NORBERG: Yes, but you would not see that program as particularly limited in any way. If you can only spend money on networking, then why would you choose networking over something else?

SCHWARTZ: Because that is your thing. There is no question.

NORBERG: Okay. That is what I would conclude too. When you bring in somebody like Roberts to do that sort of thing and he is working on it anyway, then the question is, how much of that is his devotion to his own field, and how much of it is just incapability of judging the value of somebody else's field?

SCHWARTZ: Well, that is true, and as you say, Licklider's whole thing, when he came in, was time sharing. Man-computer symbiosis. He might have gotten it from watching the DEC people play with one terminal on DDT, as far as I know. I do not know where he got that. That was his interest. (That paper which you read from earlier won the best paper award for that year.) That was his interest. I cannot recall him paying much attention to the other projects that were going on, the other research -- so-called -- at SDC using the time sharing. I do not remember how many we had at that time, but it...

NORBERG: Probably not very many by the time he left. It would be Taylor and Roberts and the ? ...

SCHWARTZ: Yes, that is right. I remember them paying attention to those other things, but I can hardly recall him. Time sharing was his thing, no question about it -- man-computer symbiosis.

NORBERG: Yes, which he would have called interactive computing, as opposed to time sharing specifically.

SCHWARTZ: Yes, that is probably right. But I do not remember that specifically. I do remember that Taylor had a much broader interest in things and projects that were going on, and in supporting or not supporting them as the case may be.

NORBERG: One name that did not come up in your discussion was Sutherland. Do you have any...?

SCHWARTZ: Oh yes. You are right; I am sorry, I dropped him out. Oh yes, I remember spending time with him. Let's see, was Taylor his assistant for a while?

NORBERG: Yes. Taylor came in to replace him.

SCHWARTZ: Oh yes. We got along, at least on the surface very well. I always thought he was a very bright, interesting guy. As I recall, he also helped cut us back some -- not terribly. I remember never being very unhappy with the results of those conversations with Sutherland and the others. There were specific things we did or did not get -- maybe less than we had proposed, but we always kept going, and it always appeared that we would, as I recall. So I do not recall any very unhappy times with any of those guys until the last year or two once we did get that network up. Yes, Ivan Sutherland -- I did not mention him. When did he come in?

NORBERG: That is all right. That is indicative. He actually replaced Licklider, not Taylor. Then Taylor replaced Sutherland. Sutherland left in the middle of 1966 to go to Harvard, and Taylor came in and took his place in the middle of 1966. Then 1969 is when Roberts took over.

SCHWARTZ: So he was there before...

NORBERG: Yes, he came in at the end of 1964, as I said before. Well, thank you very much. This has been very informative for me in terms of learning more about inside CSC and getting a perspective from someone who was on the other side of that DARPA divide.

END OF INTERVIEW