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Interviewee: Nat Rochester
Interviewer: Henry S. Tropp
Also Present: Jean Sammett
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TROPP:

This is a discussion with Mr. Nat Rochester and Jean Sammett and myself on the 24th of July, 1973, and we're at the IBM--what is it--Systems

ROCHESTER:

System.

TROPP:

Development Division on the MIT campus in Cambridge, Massachusetts. [Recorder off] Why don't we start with the MIT period and Project Whirlwind, and why don't we go back and have you tell us how you got into that particular project, how you came there. What your background was and training leading up to that.

ROCHESTER:

Well, I was working on radar during World War II. And I had been in the MIT Radiation Laboratory, which developed radar, and then, about the middle of the war, I joined Sylvania and built radar equipment for the Radiation Lab. And so at the end of the war I had a shop that was able to build, design and construct radar sets, experimental radar sets and similar things. And then came the problem of beating swords into plowshares.

ROCHESTER & TROPP: Laughter]

ROCHESTER:

And we got a number of different jobs. ...One of the most interesting ones was to build the arithmetic unit of Whirlwind I. And I also got a job building something for NSA, from which I learned something about the technology that was involved, but I can't tell you anything about that.

TROPP:

Right. This was in the cryptanalytic

ROCHESTER:

Yeah.

TROPP:

area.

ROCHESTER:

But it illustrated some of the things that were possible,

TROPP:

Mhm.

ROCHESTER:

It was from the NSA job and the Whirlwind I job that I realized what had happened. [MIT had gotten a contract from the armed services to design and construct a computer (Whirlwind I). My group at Sylvania was selected to design and build the arithmetic unit according to an architectural plan provided by MIT. The first thing they had to do was to tell us what they wanted us to do.] During the introduction to that, Bob Everett, who was at MIT--do you know Bob?

TROPP:

Oh yes, yes.

ROCHESTER:

He gave a course on computers, which was essentially his version of what he had learned, I guess, either directly or through someone else from the 1946 summer school at the University of Pennsylvania. You know about that?

TROPP:

Yeah, I know about that. This is the first I've learned that Bob was one of those twenty-five or so participants.

ROCHESTER:

Okay. I don't know if he was.

TROPP:

Mhm. But the notes of that summer course circulated pretty freely.

ROCHESTER:

Yeah. But ... what I was getting was ... an MIT version of what had been said there, I guess.

TROPP:

Mhm. Well, the Von Neumann report that you mentioned before we turned the tape on, had circulated before that summer course, so that almost everybody there had already read that. They had that as input, I guess you would call it the EDVAC report, to give it a name. And then at that summer school they were introduced to ENIAC and its operation, as well as the conceptual thinking for what was to come.

ROCHESTER:

Yes. Well, that was pretty exciting for me. I'd been thinking about what could be done and I came up with an idea for a numerical controlled milling machine, which I tried to sell Sylvania on developing. But I didn't really understand that they weren't in a position to do it. This kind of background led to an appreciation of what was going to happen. I guessed correctly that computers were going to be a very major thing.

TROPP:

Mhm.

ROCHESTER:

So I made a study of firms in this country to see who was going to benefit from it, and decided that IBM had to be the principal beneficiary and the real place to be.

TROPP:

What year was this?

ROCHESTER:

This was in 1947.

TROPP:

That's interesting because we normally think of IBM's entry as being almost half a decade later.

ROCHESTER:

Right.

TROPP:

So you were really anticipating something in terms of the company then in '47?

ROCHESTER:

Well, I simply analyzed the business situation.

TROPP:

Mhm.

ROCHESTER:

I mean who was around, who had the money, who had the capability, and who was in a position to use this [great development]. I mean Sylvania had the technical capability, that wasn't important. Everybody had that. The question was who could actually do something with an idea as big as this.

TROPP:

Mhm.

ROCHESTER:

And who would be forced into it.

TROPP:

That's the right phrase.

TROPP & ROCHESTER:

[Laughter]

ROCHESTER:

It looked like IBM, so I applied for a job and they made me a nice offer which I accepted in 1948. After cleaning up things, my responsibilities at Sylvania for quite a few months, I finally joined IBM in November 1948.

TROPP:

Going back to Project Whirlwind then, your only connection then was while at Sylvania in the design of the arithmetic unit?

ROCHESTER:

Right.

TROPP:

And other than the course from Bob Everett, did you have any other contact with the, with Jay Forrester or any, Charlie Adams, or any of the other people that were involved with the Whirlwind project? And if so, what were some of the things that you were talking about?

ROCHESTER:

Oh well, a great deal. I mean I circulated around.

TROPP:

Mhm.

ROCHESTER:

Dave Brown [of MIT], and I wrote a paper on multi position switching. These were electronic switches which were kind of new, they were used for the memory at that time. And I was pretty well acquainted with what was going on in, in the Whirlwind Project.

TROPP:

Yeah, by then that had already begun to move fairly rapidly, and after a change from its early concept as an analog device into a digital device.

ROCHESTER:

Right.

TROPP:

How about any input that you might personally have had into a digitally controlled milling machine here, in terms of what later occurred here at MIT?

ROCHESTER:

I don't believe that I had any direct impact on the program. I came up with this idea, and I think I might even be able to locate some of the things I wrote on it. But I didn't publish, and I was not able to convince Sylvania that this was a great thing to do.

TROPP:

Mhm.

ROCHESTER:

So I was interested to watch later, and become acquainted with some of the people who developed it at MIT.

TROPP:

Mhm. ..In terms of your investigation at IBM, I'm trying to think back and summarize this capability or potential that you are talking about, because back in the thirties they had sponsored the work of Ben Wood and Wallace Eckert at Columbia. Were you familiar with .. those machine applications in terms of Ben Wood's work on statistical analysis of tests, or Eckert's work on computation in astronomy?

ROCHESTER:

No. I felt that the most important application of the computer ...would be in industry and commerce. And the astronomical calculation type of thing seemed to me to be interesting, but not really the main thing.

TROPP:

That's interesting because, you know, thinking back to IBM in the pre-war period, the little they did with electronics was primarily from that viewpoint. Looking at some of Halsy Dickinson's patents.

ROCHESTER:

Mhm.

TROPP:

...it was primarily to see if they could use electronic means to improve the devices used in business applications, primarily.

ROCHESTER:

Yeah. Well, I also found out that IBM was a good place to work, in the sense that people who worked there thought it was a great outfit. That's important.

TROPP:

Well, if I remember right, and you can correct me on this, in 1948 there really wasn't a research and development effort, organized effort, was there yet?

ROCHESTER:

Oh yes, yes. There was a lot, there was a lot of work going on. I joined Ralph Palmer's crew, and he had been responsible for developing the 604. This was an electronic calculator, which was essentially designed to do payroll calculations. Are you familiar with this machine at all? And it just took in master cards for, for somebody's payroll and time cards, and would compute a pay check and a new master card. That was the type of thing that was designed to do.

TROPP:

Essentially a multiplier?

ROCHESTER:

Well, but it had a program which was plugged, not stored. It would run through this program, and execute it. So you could do moderately complicated things by the standards of those days.

TROPP:

Mhm.

ROCHESTER:

for business machines.

TROPP:

Mhm.

ROCHESTER:

.. But I was convinced that, that computers were really what was going to be important. IBM people who were influential were much more concerned about the question of whether the punched card had a visible future, or whether magnetic tape posed a significant challenge to it. So after I had worked out a number of different proposals for computers that I thought really ought to be the kinds of products that IBM should have, a study was set up of the significance of magnetic tape. You have probably encountered this with Werner Buchholz. I was given the job and I hired him.

TROPP:

Mhm.

ROCHESTER:

And I was also told to work with Steve Dunwell. You encountered that name?

TROPP:

Yes. But I haven't talked to him yet.

ROCHESTER:

Yeah, well anyway, Werner, Steve and I had a project to come up with an analysis of what magnetic tapes meant for IBM, and what IBM should do about it. The result of this, eventually, was the 702. The tape processing machine number 702; but there was an intermediate step. After preliminary ideas were worked out, Palmer and I don't know who else, perhaps Wally McDowell, who I guess was Vice President in charge of Engineering .. said, "Well, you have to prove that you can really build a machine like this." And so I worked out the architecture of the test assembly. Have you encountered that name?

TROPP:

From Dr. Buchholz, yea.

ROCHESTER:

That was a general purpose computer built out of parts of what we could lay our hands on quickly. The parts were a 604 computer which we used as an arithmetic unit, and an empty 604 rack with its power supply; a number of bushel baskets full of 604 plug able units that we built control circuits out of; and a Williams tube memory that Phil Fox designed and built. And so this machine was constructed in Poughkeepsie, and it ran successfully, and it performed computations. And I have right here a deck of cards

TROPP:

[Laugh]

ROCHESTER:

that were computed. [Pause while he gets them] That was January 1950. [Sound of stacking cards]

TROPP:

Wow! I've heard about this stack of cards, I didn't know they still existed.

ROCHESTER:

This says January 1951. I think that's wrong. This was written long afterwards. "Sines and Cosines Calculated with Various Increments by the Runge-Kutta Method Using a Test Assembly." [Note: This computation was made on Sept. 12, 1950, when the Test Assembly ran from 11am to 4pm and did this computation and others. NR 12/9/85].

TROPP:

I think the next statement is of interest too. "This was IBM's first Von Neumann type of general purpose computer," and by that you are referring to this combination of 604

ROCHESTER:

Yeah.

TROPP:

assemblies and arithemetic units

ROCHESTER:

Yeah.

TROPP:

and the Williams tube memory.

ROCHESTER:

Yeah.

TROPP:

"The only earlier ones were the IBM Harvard Mark I and the SSEC." And then you have your description of, "test assembly was made of a 604, a 604 frame filled--"

ROCHESTER:

Yes. We arranged 604 plug able units

TROPP:

To serve as--

ROCHESTER:

to serve as a control--

TROPP:

"on a 500 word cathode ray tube memory designed by Phil Fox."

ROCHESTER:

Right, that's it.

TROPP:

But you think the date was January of 1950, and that would fit more

ROCHESTER:

Yeah.

TROPP:

with the information that I have, as opposed to January of '51.

ROCHESTER:

Right.

TROPP:

That would fit the other information that I—

SAMMETT:

How history is made.

ROCHESTER:

[Laugh].

SAMMETT:

Just change the date.

TROPP:

No .. we can, this is interesting, Jean, because I have already talked to Dr. Buchholz about this and the dates come out the same. Now if the dates, if his date was '51 I would not have said a word about that. It's just that it doesn't fit.

ROCHESTER:

Right.

TROPP:

with what happened later.

ROCHESTER:

Yes.

TROPP:

And .. the .. the question that Jean asked is, I think will come up later about the sequence, because I wanted to get your input on, you know, the same questions that I have asked other people who were involved in it. And that's how, you know, you kind of put together the time sequence of events.

ROCHESTER:

Right. Well, with that question of dates, there was--some secretary house-cleaned my files, and subsequent to that, I wrote the notes in that paragraph to identify what this deck of cards was.

TROPP:

[Laughter]

ROCHESTER:

And I no longer had easy access to the reports I'd written at the time and so forth.

TROPP:

Are there any photographs remaining of the test assembly?

ROCHESTER:

I don't believe so. I don't know if any photographs were ever made. IBM was very secretive at that point. IBM did have--

TROPP:

The hush-hush aspects of this are interesting.

ROCHESTER:

Yeah. When, when I came to work for IBM I was told that I had written my last paper that would be published in a journal.

TROPP:

Mhm.

ROCHESTER:

That seemed to be the tradition in the whole field of computers.

TROPP:

Well, one of the questions that came to me from outside, from an outside source, was because of the secrecy, the people who were not part of the IBM organization have raised the question that was it not only a hush-hush project, but was this done deliberately in order to act as a smoke screen so people didn't know what you were really working on? Any my feeling at this point is no, it was a very serious project.

ROCHESTER:

Yes, it was.

TROPP:

But to outsiders looking in, after the fact, it looks like it to them, at least the claim is that it wasn't a serious project, it was only a project to take people off into another direction while you went in the real direction.

ROCHESTER:

No, it was, it was a perfectly serious project. The, the idea of building a Von Neumann type computer as a means of using magnetic tape, which is what we were talking about. In other words, when they (IBM management) were talking about just using magnetic tape to replace punched cards. I think that this simple idea wasn't viable, and the 703 was the proof at that time that simple ideas weren't viable. That was what the 703 was. A lot of people never gave up this idea that you didn't need a computer.

TROPP:

Mhm.

ROCHESTER:

Buchholz and Dunwell and I concluded that we did need a computer. And so one thing that people were skeptical of is, was the question of whether or not we need a computer. Another was, "would a computer work?"

TROPP:

Well, I think the deck of cards you brought out has a good deal of significance. One of which, it answers the question, "Did the TPM, this test assembly, ever really run?"

ROCHESTER:

Yeah.

TROPP:

[Laugh] And those cards are, you know, evidence of the fact that it did run.

ROCHESTER:

Yes, it did run. ...

TROPP:

And again, this part of the information that's not available. But that's proof of the pudding in that gray steel cabinet.

ROCHESTER & TROPP:

[Laughter].

TROPP:

The question that Jean was raising, and I'll let you discuss it because it will lead me into another one, is that the direct result of this is into the 702 as opposed to the 701. And one of the questions that came up in earlier discussion, was one that I raised about the fact that the tape .. mechanism for the 701 and the 702 were not compatible, were not inter changeable. And since the 702 came out later, and it had many desirable characteristics, the people who already had 701s delivered were, some of them were unhappy because they wanted to be able to use these characteristics of the 701 and discovered they couldn't.

ROCHESTER:

Mhm.

TROPP:

And you might want to talk on or around that sequence of events, and how that, I think I know now how that occurred, but I would just as soon have you say it rather than me.

ROCHESTER:

Well, the .. the Tape Processing Machine project was ... aimed at building a commercial computer: designing it, building it, and convincing IBM to market it. This was one obstacle that management put in our way. Prove that you can do what you claim you can do. And so we did, we proved it. Then later, after we did that, some of the people who were working on it decided that the test assembly, itself, was a viable basis of a product. And there was an engineering effort that went on for some years with a group of people--Truman Wheelock and Woodbury--

TROPP:

Oh, was [Bernie] Toben part of that too?

ROCHESTER:

Toben, yea.

TROPP:

Rex Rice, was Rex--

ROCHESTER:

I don't know, I don't remember. But they, they tried to convert that thing which we'd, we'd just put together out of parts just to make the easiest route from where we stood to an operating computer. And they tried to convert that into a product. It never really got the stamp of approval, and it was never marketed.

TROPP:

Well, that's, that's raised a number of questions, and I'll try to sort them out. I think of Woodbury and Toben and then later Wheelock, in terms of the development that started with the CPC, and when they joined IBM ended up with what we know as the Wooden Wheel;

ROCHESTER:

Yeah.

TROPP:

which is named after Woodbury, Toben and Wheelock. And .. that was a direction of machine architecture or conceptual design that was very different from the 701 concept.

ROCHESTER:

Yes.

TROPP:

And .. I guess I'd like to talk about the 701 and how you got involved in that and what you know about it, because apparently there were a number of factions within the company in terms of directions to go to build .. general purpose computers.

ROCHESTER:

Okay. My recollection about the Wooden Wheel and its relationship to the test assembly may not be perfectly correct, because now that's inconsistent now. But Wheelock did work on the test assembly, and somehow I have a recollection that that evolved into eventually the Wooden Wheel project. But the Wooden Wheel was not a stored program machine in the ordinary sense.

TROPP:

Right, right. It came out of the Card Programmed Calculator environment that originated on the West Coast with Toben and Woodbury at Northrop.

ROCHESTER:

Yeah. Okay. Well, the .. then the next step after, after getting the test assembly running, or actually after I had specified what's now called the architecture

TROPP:

Mhm.

ROCHESTER:

of the test assembly. Then a group of people which included Lou Stevens and Werner Buchholz, Truman Wheelock, and some others, actually built the thing and made it run. I wrote some programs for it and I ran the first program on it. But at that time I was busy working on what became the architecture of the Tape Processing Machine.

TROPP:

Mhm.

ROCHESTER:

And .. Buchholz later worked on that. We worked on it together. And I still have the Record of Design. .. So, out of that came the Tape Processing Machine.

TROPP:

That's interesting. The patent date on that that I have was filed in 1954.

ROCHESTER:

Mhm.

TROPP:

So by 1954 that was pretty well complete then?

ROCHESTER:

Well, that's the 702 really. Or was it--

TROPP:

This is called the TPM patent.

ROCHESTER:

Okay. Yeah, I guess so. All right.

TROPP:

It wasn't granted until 1966.

ROCHESTER:

Right

TROPP:

[Laugh]

ROCHESTER:

yeah. Well, then, and at the same time that we were doing this engineering, there were discussions of product line. And I would go into meeting after meeting, strongly support the view that we should put out a computer. And I can recall a certain IBM executive saying, "No IBM customer will ever pay a thousand dollars a month for an IBM machine." I just didn't get anywhere with that.

TROPP:

Mhm.

ROCHESTER:

People in power just weren't ready to but this sort of thing.

TROPP:

When you say .. computer, you're still taking about primarily for business and industrial applications?

ROCHESTER:

Well, we were interested in the gamut of things, but we were <u>most</u> interested in what we thought IBM <u>most</u> needed.

TROPP:

Mhm.

ROCHESTER:

And what I thought, Dunwell thought, and I guess Buchholz thought, was that what IBM needed was a commercial computer,

ROCHESTER:

because there was this tremendous amount of business that could be done so beautifully with computers. And that was a correct guess. I mean in retrospect I would say that I believe that was right.

TROPP:

Well, looking at the origins and evolution of the 701, which had a limited market,

ROCHESTER:

Right.

TROPP:

but was, you know, whose decision to build was made after Cuthbert Hurd had already gotten firm orders

ROCHESTER:

Mhm.

TROPP:

from a number of companies. What influence did this have on the ultimate decision to go ahead in a totally different field?

ROCHESTER:

Well, this was, this was somewhat strategy on our part. In other words, what we .. the Korean War came along

TROPP:

Mhm.

ROCHESTER:

and .. and it appeared to us that we could build a scientific machine, and .. that we could .. we could get solid enough orders, because the customers would understand better what they were, what that were getting, and we could perhaps break the ice with this machine. And that's precisely what we did. In other words--

TROPP:

This was originally the Defense Calculator?

ROCHESTER:

Yea. Haddad and I came up with a plan of what we could do. And Hurd came up with a convincing story that he could sell what we could build. And .. we were teamed up together, and we managed to sell IBM management, the idea of producing these machines as a contribution to the war effort. Not as furthering IBM's real future in this product line, but as a way, as something that was very important to do.

ROCHESTER & TROPP:

[Laugh]

TROPP:

So you came up with the idea and Cuthbert Hurd then took the swing around the country and came back with seventeen or eighteen firm orders, and I guess eventually nineteen were built.

ROCHESTER:

Well, initially six.

TROPP:

Initially six?

ROCHESTER:

Yes. So the first authorization was to build six machines. An experimental model, and six production models. And then--but in the meantime Cuthbert kept on selling, and the number, before we actually shipped any, the number was increased to twelve, and subsequently it was increased to eighteen. And then for--I've forgotten exactly what the story was, but some customer just demanded one more of these machines. This was after we were well along on the 704, which is a successor. So nineteen were built, nineteen and the experimental model; actually twenty.

TROPP:

Excuse me, Jean, you look like you have a question.

SAMMETT:

Yeah. I'm still confused on the sequencing in the following respect: you said that there were a series of meetings in which you and other people tried to persuade IBM management to build a business type machine.

ROCHESTER:

Right.

SAMMETT:

a machine for business. Now was that activity, in some sense, interrupted by the 701? Is that a fair way to put it? I'm still confused on

TROPP:

Well, as I--

SAMMETT:

where the 701 fits in

TROPP:

Okay, as I put together--

SAMMETT:

right between the, between the TPM and the actual 702.

TROPP:

As I put together--

ROCHESTER:

We designed and built the TPM and made it run; and then we designed and built and marketed the 701. ...

TROPP:

As I put the story together, and I'm ready to be corrected, that conceptually the 702 was there in minds and maybe even on paper before the Defense Calculator was begun.

ROCHESTER:

And the TPM really was a first model of the 702, and the 702 was an improved version of the TPM.

TROPP:

Right, right. So that in sequence of development the 702 is really prior.

ROCHESTER:

Right.

TROPP:

to the 701.

ROCHESTER:

That's correct.

TROPP:

But it took the Korean War to get the impetus for the 701, and the 702 just followed naturally. .. Well, not so naturally, but it looks like a very natural thing afterward, in the sense of a general purpose computer for commercial needs.

ROCHESTER:

Yes. Well, one of the, one of the crucial things is that, .. that we, that by the time we did that we had actually built, delivered and been paid for these computers and they were running, and they were bringing in a, a very surprising amount of revenue. And the reason for this is that electronic machines, even built out of vacuum tubes are better than mechanical machines, because you can repair them indefinitely. I mean, whatever goes wrong can be fixed, whereas mechanical machines were out. This hadn't been anticipated in the financial planning by the people that forecast things.

TROPP:

I think there's another aspect, Jean, and maybe, you want to comment on this, and this is the fact that the 702 moved directly into a competitive market with UNIVAC. And that, I'm sure had, had equivalent impact on the ability to convince management to go ahead in this area.

ROCHESTER:

Yes.

TROPP:

You might want to comment on that.

ROCHESTER:

Well--

TROPP:

The 701 was not a competitor in that sense.

ROCHESTER:

Yes. That's right. Yes, there was pressure from our customers.

TROPP:

Mhm.

ROCHESTER:

for, for such a machine. And .. another, another essential ingredient to all this was Tom Watson, Junior, who had been an aviator in World War II, and then had come back to IBM to see, see if he could make any progress towards management.

TROPP:

Mhm.

ROCHESTER:

And .. he wanted something to, that he could put his name on. He became convinced by Hurd and by me and Ralph Palmer and other people, that this was a good thing to bet on. And so he backed us. I don't think we could have done this without his backing.

TROPP:

I think that's a very critical point that has come up in a number of places, that it's clear that there was a good deal of in-fighting going on in terms of direction development.

ROCHESTER:

Right.

TROPP:

Not so much a clash of personalities as a clash of a concept of the future.

ROCHESTER:

Right. That was, that was precisely it. It wasn't really a clash of personalities particularly, but there were very many ideas as to what should be done and there was no proof about who was right.

TROPP:

Mhm.

ROCHESTER:

And I can remember one very important meeting, really the one that got the 701 out of, out of the confused state it was in and into a really high speed project. .. Tom Watson called the meeting at 590 Madison Avenue, and he had together in one room all of the most, all of the noisiest people

TROPP:

[Laugh]

ROCHESTER:

who were concerned with this subject. And he had me describe what we thought we could build, and he had Cuthbert describe how he thought he could sell what I had just described, and then he went all around the room and asked people what they thought of this idea. If they thought we should do this, or what they thought we should do. So then when he got all the way round he said, "Well, this is what we are going to do. You and you and you find other things to work on while

TROPP:

[Laughter]

ROCHESTER:

this project is going ahead."

TROPP:

This was Tom Watson, Senior?

ROCHESTER:

Tom Watson, Junior.

TROPP:

Oh, this was Tom Watson, Junior, who called this particular meeting?

ROCHESTER:

Right.

TROPP:

Where does John McPherson fit into this in this period? Where were his views and additives, because he, doesn't he end up going off into another, you say another project?

ROCHESTER:

He wasn't, he wasn't--I don't believe he was at that meeting. He might have been, but I don't think he was. If he was, he didn't take a strong position. There were people that took very strong positions against, and very strong positions that quite different things should be done and all sorts of--you can imagine.

TROPP:

Well, going back to the 701, I guess one of the sequences that I'm interested in is the relationship between what the people on the, in the aircraft industry were interested in doing and their demands for computational capability. And your concept of what you could build, not what you wanted to build, but what you saw as a reasonable thing you could come up with.

ROCHESTER:

Well--

TROPP:

How did those various things mesh?

ROCHESTER:

One of the things that we did with the 701 design was to leave out of hardware, leave to programming, anything that we thought we reasonably could. Because we were very scared of the idea of putting a machine as complicated as this in a customer's office. It was so vastly more complicated than anything we had marketed before, that we felt very timid. And so we didn't put in a lot of the things that we felt really ought to be there. Like floating point, for example,

TROPP:

Mhm.

ROCHESTER:

we programmed that. And we left twenty-five percent of the frames empty,

TROPP:

Mhm.

ROCHESTER:

So that later they could be filled in. In fact, that's what the 704 was.

TROPP:

Mhm.

ROCHESTER:

704 was a redesign of the 701, .. to make a really practical machine.

TROPP:

Mhm.

ROCHESTER:

And it added floating point, indexing and a variety of very crucial improvements. But they were all things which you could get around, although at a cost of performance by, by programming. And so the 704 was really the machine we had in mind building at the time we designed the 701.

TROPP:

Looking back in, in retrospect, had the 701 been kind of an open-ended project with no fixed number on the production line? Do you think that the number produced would have been quite larger, or do you think that it would have held up the ultimate development of the 704? You know it's interesting, here's IBM's first production model of a general purpose computer with a very limited production, the production limited to precisely the number of orders you had, plus what now?

ROCHESTER:

Well, I don't think so. I mean I don't think the thing was done unintelligently. That is, we didn't feel that we had designed a very good machine, because we knew we had just leaned over backward to make it simple.

TROPP:

Mhm.

ROCHESTER:

And we were quite sure, or we hoped, I guess, that really it should be a much more complicated machine that would be more efficient and do what the customer wanted better. And so we wanted to keep the number down and we wanted to get from there as soon as we could to .. the 704.

TROPP:

That's an interesting approach because you just recounted the difficulty of even getting the go-ahead on this limited production and you were already thinking in terms of the next machine. [Laughter]

ROCHESTER:

Well, we were, we were thinking in terms not just of the next machine, but we were thinking in terms of today's world.

TROPP:

Mhm.

ROCHESTER:

That's what I went to IBM to try to create, that's what I really visualized it at the time. And .. I was thinking of today's world in the sense of what's happened in the use of the computer in business and in industry. And, incidentally, in science; I mean I thought that too would be very important.

TROPP:

Well, at that time it was, I think pretty generally accepted that the scientific world wasn't going to need too many of these.

ROCHESTER:

Yes.

TROPP:

That, that seemed to be a prevailing opinion among scientists. I mean, they wanted them, they knew they had need for them, but nobody really foresaw the fact that there would be such a large number of them. A few would perhaps take care of the scientific problems that were around. Jean?

SAMMETT:

That seems to be in conflict with what I had the impression as the general--I've had the general impression that most people thought that the largest opportunity was, in fact, in the scientific field, not in the business field. You're saying that everybody that had that impression didn't really.

TROPP:

No, I think that--

SAMMETT:

There's a conflict between what you are saying and what I thought most people were thinking.

TROPP:

I think, I think that what you are saying is absolutely correct, but I think that they looked at these massive computers and realized that if you had a number of these in various places around this country and around the world, they would probably take care of all the scientific problems that needed solving. They were absolutely, you know, so fast, and they could do so many things so rapidly. I don't think at that point in time most scientists had really thought about what the computer could do for them. They didn't think of it expect in terms of solving specific problems.

SAMMETT:

I understand that, but I thought little as they may have thought they needed, that was still an awfully lot more than what was envisioned for need in the business data processing area.

TROPP:

I think the business data processing area had, was the one that had the least amount of vision. But what I am saying essentially is something like a report that was written in the late forties by a number of prominent people that I have not chased down, so I'll, it's only third hand information, to the effect that three or six of these would probably solve the world's computational, scientific computational problems for a long time to come. There were people, there were isolated people like yourself, though, who saw the business application. I think one of the most interesting is a machine conceived and designed by George Stibitz for just that purpose, a desk size electronic computer for business application that was to be built by the Barber-Colman Company. And this conception is about 1946. And a survey done in about 1949 shows a minimal market of about 200 customers. [Laughter] But there weren't very much people who saw that avenue of direction. I agree with you, Jean.

ROCHESTER:

Well, let me mention another thing. I was familiar, at the time the 701 was new, with Turing's paper. I knew that we were building machines that could solve any problem that any machine could ever solve, provided three things were true: one is you were willing to write the program,

TROPP:

[Laughter]

ROCHESTER:

another is that you were willing to pay for having the program run. The third was: if you were able to understand how to do it. To understand how to write the program. I believed at that time, and I still believe, that we had come to a new level of machine, a new level of product. And these things were very important. We could build bigger and faster ones later, but those early ones could still do everything subsequent ones could do if you were willing to wait and to pay,

TROPP:

That's right.

ROCHESTER:

if the program ran enough.

TROPP:

Well, Von Neumann's comment to a number of people when he was designing the machine at Princeton with, I think a 1,024 words of memory, that this was almost like an infinite memory, [laugh] you know, if you were just willing to work hard enough to solve the problems that you were interested in doing.

ROCHESTER:

He was very convinced of that. That is .. and when he was a consultant to us during the 704 time, he objected to the idea of having a larger memory than a thousand words. He thought that was frivolous.

TROPP:

For him it probably was. [Laughter] Nobody else in the world. [Laughter] I, I guess this is a, a good point for me to turn the tape over.

[Recorder off]

[End of Side 1]

[Start Side 2]

ROCHESTER:

Okay. Well, 702 was successful, but it was ... it was redesigned and a new model came out, the 705 which had all sorts of improvements. To see exactly which they were I'd have to look back to some of the records that I have. Subsequently, the 709 was designed and the 709 was supposed to be the successor to both the 704 and 705. The 704 was the successor of the 701, and the 705 was the successor of the 702. The 709 was supposed to be the successor to both. Four plus five is nine.

TROPP:

Well, this--that successor idea is one you might want to elaborate on. The idea of designing a single machine to serve both the scientific and commercial communities.

ROCHESTER:

Right.

TROPP:

How you got to that decision level and what you think about it.

ROCHESTER:

Well, the .. the thing, what we observed was that we had a lot of customers that were doing both scientific computation and commercial computation. And they tended to use these two different machines, and the problems were really pretty close. I mean when you sit back and look at it in a philosophical way, there seems to be really no reason for this tremendous dichotomy.

TROPP:

Well, not only physically two different machines, but usually physically in two different places with two different groups of people who didn't communicate. I think that--

ROCHESTER:

Right, yes. And they weren't interchangeable and they didn't provide each other with the support that they should; in fact they were usually battling. Usually the scientific work was done in the engineering department, and the commercial work was done in the .. financial end of the business. And so we just felt that this was wrong for our customers, and we ought to provide them with a single machine that would serve both groups, and we thought we could. I guess there were some people who used the 709, the 7090 and the 7094 for commercial work. There were a lot, I guess, yes.

SAMMETT:

[Inaudible]

ROCHESTER:

Yes. ..The rest of the sequence--I can't give you accurately without, without looking things up. Let my see. Well, we didn't really fully achieve .. the kind of machine .. the kind of machine that would serve both fields fully successfully until, until 360, which was actually the real, the real break in design that occurred after the 701, 702. The 701 and 702 laid out a sort of main line that IBM followed, and all during that period we were continually having debates. Should we stay compatible or should we break out into something new?

TROPP:

Mhm.

ROCHESTER:

And the advantages to our, of staying compatible were that we wouldn't make huge problems for customers in converting. The disadvantage of staying compatible was that we knew we could build better machines, and the advantage of having a better machine. So this original architecture for the 701 and 702 really lasted up until 360.

TROPP:

The, the question of compatibility, as I mentioned earlier, came up in connection with the tapes on the 701, 702. The incompatibility of those two tape mechanisms .. was apparently frustrating to at least a couple of the 701 users. And so this concept of compatibility or single machine to serve both worlds, really was a much later thought in terms of design. Because as I see the tape mechanisms of the 701 and 702: the 701 was there to do the job and the 702 was really an improvement, and there was no thought at that time of the fact that you might want to interchange these two, because this one was so much better and why not design it so that you can replace it on the 701. Had that question ever come up during the design of the 702, of this interchangeability or compatibility?

ROCHESTER:

Yes, but we were, we were sort of overwhelmed by the problems we were dealing with. One thing that was done with the tape processing machine is that different engineers were assigned different parts, and they were allowed to design those parts as they, as they felt best.

TROPP:

Mhm.

ROCHESTER:

And when we got it done it was almost impossible to keep it running, because there were all sorts of diverse circuit techniques being used in different parts of the machine.

TROPP:

Mhm.

ROCHESTER:

And so the 701 benefited from that, in that we standardized the things that people were allowed to design. In other words, a standard design manual written before the detailed designs were worked out. And the same policy was followed with the 702. We were just learning what the problems were and how to deal with them. And certainly compatibility was a concern, but we were in a state of being sufficiently overwhelmed by the size of the problems we were dealing with, that we weren't able to address it adequately.

TROPP:

Yeah, Jean?

SAMMETT:

Nat, I have a questions with regard to the 709 which you said many people wanted to use as the joint successor for the 704 and 705. How much consideration was given to the fact that the binary 708 which you were going to carry on, and the 709 was likely to give apoplexy to the commercial customers, who at that point didn't understand binary, presumably? And is perhaps that the reason that the 709 did not achieve that much success in the commercial application areas?

ROCHESTER:

Well, it was certainly a consideration. This was, this was, I mean we were always wrestling with this question, and we wrestled very hard with it when the original decision--with the original decision to make the binary 701. And I think our most important motivation in doing that was to avoid, well it was to make a break, at a time when we could, with the decimal tradition. I mean the decimal was so strongly built into IBM.

TROPP:

Mhm.

ROCHESTER:

and into IBM's product line, and into its thinking; ten holes and two control holes and a punched card, and counters that count to ten, I mean everywhere you looked you saw ten. And so we felt that if we built a decimal machine then IBM would never be able to build a binary machine. And .. we felt this would inhibit the ultimate growth.

TROPP:

This decimal thing is interesting, because Byron Phelps had a large cabinet in his office with pieces of hardware from various machines that he had been associated with, and he pulled these out at various points, and one of the early ones was [a] counter, and I looked at that and said, "Oh, that's the same counter, that was on the Mark I at Harvard." And he said, "Of course, this is one of our standard pieces of equipment." This is the decimal counter that was used along with the relays that were a standard IBM equipment. And this is what's used in the Mark I; at the same time there are many stories of Howard Aiken in the same time period, talking to people about doing arithmetic in some number base other than ten. Apparently, one of his favorites was seven. But he wasn't, you know, hung up on, on doing things decimally either.

ROCHESTER:

Right.

TROPP:

But that was, as you say, this was the way the IBM equipment was built.

ROCHESTER:

Yes.

TROPP:

All decimal.

ROCHESTER:

Yea. In other words, there was, there was such a decimal mentality around that we felt that if we just went decimal, it would close off our future. So that was the real thing that made us decide to go binary, on the 701.

TROPP:

Might back up into some of your own background and motivation. You mentioned reading Turing's paper.

ROCHESTER:

Yes.

TROPP:

When did you first learn of Turing's work and how did it come to you?

ROCHESTER:

Well, long after, long after I had gotten into computers,

TROPP:

Mhm.

ROCHESTER:

I don't know, I originally started out to be a mathematician as a, as a freshman. It would have been an easy way to go. But I decided I felt very uneasy about physical things, and so I really ought to get going with that, and not to stay in mathematics and ignore the real world. So I went to it, and became an electrical engineer.

TROPP:

Where, where did you go to school?

ROCHESTER:

MIT.

TROPP:

Here at MIT.

ROCHESTER:

Yeah, And so I took quite a bit of mathematics in school, but not, not a whole lot. Never read Turing's paper until after, I guess it must have been after the 701 had been designed, or in that same time.

TROPP:

Mhm. The reason I asked the question is because I've heard from a number of people that they were introduced to Turing's paper by Von Neumann, who said, "If you're going to" you know, "work in this field, this is where you start. This is the first thing you ought to read." [Laugh]

ROCHESTER:

He never said that to me, and I knew him well. In fact ,I don't think he ever did mention Turing's paper to me, but on the other hand, I wasn't a mathematician, and he was; so he would talk about mathematics to mathematicians and talk about engineering to and engineer.

TROPP:

[Laughter]

ROCHESTER:

Talk about business to businessmen.

TROPP:

Going back to your training here at MIT, .. quite a tradition in computation had already existed here; Bush's work,

ROCHESTER:

Right.

TROPP:

Harold Hazen,

ROCHESTER:

Yeah.

TROPP:

work in control theory. It goes back to the twenties and thirties. How much of that [work] were you exposed to as an undergraduate here in electrical engineering?

ROCHESTER:

Well, I .. I knew about it, I knew the different machines. The cinema integraph was one that you didn't mention.

TROPP:

Mhm. Right.

ROCHESTER:

There were a bunch of them around. And I was influenced by their existence, but not, not directly by the details of what was in them.

TROPP:

Mhm.

ROCHESTER:

Really, I felt at that time that, that something like a computer needed to exist. I mean the idea that I had was, I'd like a bushel basket full of hardware that I could plug into my brain

TROPP:

[Laughter]

ROCHESTER:

to make it go better. Now I have it right here, the connection isn't quite as good as I visualized

TROPP:

[Laughter]

ROCHESTER:

at that time. But I was, I actually got into acoustics. ... But then the war came along, World War II, and .. the nearest thing to acoustics was microwaves, because you're dealing with wavelengths that are the same size as people, roughly. So you have very messy problems of that sort, with an additional dimension, the additional problem of one more dimension.

TROPP:

Mhm.

ROCHESTER:

And so I got into microwaves, and then I gave you the history before about how this led to computers.

TROPP:

Right. In, in terms of .. your decision to join IBM, you had already been introduced to what Bob Everett knew, what was going on

ROCHESTER:

Yes.

TROPP:

here at MIT, what was going on at the Moore School. What knowledge did you have about what was going on at Harvard, what was going on in England, either at Manchester or Cambridge or the National Physical Laboratory? Did you have any information on those projects that were going on?

ROCHESTER:

Yes. Well, oh sure, I knew many of the people. I mean I think--by that time I had met Wilkes, I believe, I'm not sure.

TROPP:

Well, Wilkes was at MIT at one point, or a number of times.

ROCHESTER:

Yeah. He had been in and out of MIT a lot.

TROPP:

Mhm.

ROCHESTER:

And there were meetings, there was a meeting at Aberdeen which almost everybody came to. I've forgotten what time, the date, it was very early.

TROPP:

Was this one of the early ACM? No?

ROCHESTER:

It was long before the ACM existed. It was, it was before the Eastern Association for Computing Machinery existed.

SAMMETT:

Well, then it had to be before 1947, because that's the official

TROPP:

Right.

SAMMETT:

date for ACM.

TROPP:

Well, we've gone back to '46, which was the Moore School, Summer School Program.

ROCHESTER:

Well, this must have been 1947 then.

TROPP:

Mhm.

ROCHESTER:

Was there a meeting at Aberdeen in 1947?

TROPP:

Yeah. I'm trying to remember under whose auspices ... right now that escapes me, but there was a meeting in that time period at Aberdeen.

ROCHESTER:

Right, yeah. Because that was where there was a big computer,

TROPP:

Mhm.

ROCHESTER:

for ballistic, trajectory computation.

TROPP:

The Bell, The Bell Lab Mod 5 or Mod 6 was there, and wasn't the Mark II there as well?

ROCHESTER:

They had a number of computers, and I just don't know what there were.

TROPP:

Well, let's get on to the subject of Von Neumann.

ROCHESTER:

Okay, great.

TROPP:

In terms of your contacts with him and some of your memories about Von Neumann, anecdotal or otherwise.

ROCHESTER:

Yes. Well, he was certainly one of the greatest people I've ever encountered. He had an incredible ability to take a, take a messy area and make it clear and simple. But he'd do this in a way that would be much more powerful than you would expect it to be possible. You wouldn't realize the generality that was possible that he would create in the design. One of the connections I had with [Von Neumann] was, he was very much concerned with how to program computers. And in, in the original series of three reports, the Burks, Von Neumann and Goldstine, there was a procedure for writing programs so that you could make corrections. There was essentially a clerical concept of how to assemble a program.

TROPP:

Mhm.

ROCHESTER:

I mean, there wasn't any idea that the machine would do this, but it was just a process that you could carry out yourself. Have you--are you aware of this?

TROPP:

Mhm.

ROCHESTER:

Okay. And .. so, from that, a number of people, independently, came up with the idea of writing .. assembly programs. I did, Wilkes did, and I suppose others did. And I don't know if Wilkes' assembly program ran first or mine ran first, we didn't know of each other at the time.

TROPP:

Mhm.

ROCHESTER:

We didn't know of each other's work in this. I do know, as a matter of fact, I published the first paper on an assembly program.

TROPP:

Do you have a copy of that publication? ...

ROCHESTER:

It's Volume I, Number 1 of the Electronic Computer Transactions of the IRE. .. I have, I have that issue right here down the hall. .. And the, the idea, I mean the basic idea was to free, free yourself of the terrible problem of having to deal with, of changing programs. I mean, bugs were well-known right from the beginning, and in absolute programming when you make a mistake, well then you're got a lot of erasing to do because you would have to change all of the subsequent addresses that you had carefully worked out. And so by using symbolic addresses, and then letting the machine assign actual numbers to it, why, it became much less laborious.

SAMMETT:

The citation is Transactions of the IRE Professional Group on Electronics, Volume EC2, Number 1, March 1953.

TROPP:

March '53. That's the publication?

ROCHESTER:

Yeah.

TROPP:

Yeah. That's always later than, much later than the paper. [Laugh]

ROCHESTER:

Yeah.

TROPP:

Thank you Jean. [Laugh] I love the comment that Wilkes makes about his first program, and discovering the errors in it, and then realizing that he had discovered something he was going to do for the rest of his life: De-bugging.

ALL:[Laughter]

TROPP:

Well, do you remember any, any particular incidents, specific incidents with Von Neumann that you can recount in terms of either, you know, the development of the 701, or other areas?

ROCHESTER:

Well, one term that was in wide use at that time was the Von Neumann time constant. Are you familiar with this?

TROPP:

That's six months or a year and a half, depending of who you talk to.

ROCHESTER:

Right.

TROPP:

I wish I knew exactly what the constant was. [Laughter]

ROCHESTER:

Yeah. Well, I thought, I recall it being nine months.

TROPP:

Nine months. Okay, that's another--it's in that range. Right.

ROCHESTER:

That's right. We're in the ball park. That was how long it was from any given time until the computer at the Institute for Advanced Studies would be running. It was a constant. [Laugh]

TROPP:

The .. that brings up an interesting question that I'd like to have your comment on. This is your attempt or decision to use the Williams tube memory, as opposed to what Von Neumann was trying to do and that's use the Selectrons here. Was there a serious thought to using the Selectron on the 701?

ROCHESTER:

There was a serious evaluation of the Selectron.

TROPP:

Mhm.

ROCHESTER:

We .. we went down and saw the work that was going on at Princeton, and I knew a fellow, Jan Rajchman at RCA. He concocted the thing.

TROPP:

Right. It was his conception, yes.

ROCHESTER:

Yeah. And I don't know if this preceded or, I think the idea preceded the Williams, the Williams tube, didn't it?

TROPP:

No, I don't think so. I think the Williams tube preceded it, but they were essentially in the same environment,

ROCHESTER:

Yeah.

TROPP:

roughly in the same time frame.

ROCHESTER:

Right. Well, we felt that the, that the Williams tube scheme was much simpler and could be made to work all right. We eventually had to make our own cathode ray tubes.

TROPP:

That's another question I meant to ask you earlier. I'd heard that there was a capability of making tubes at IBM,

ROCHESTER:

Right.

TROPP:

that they were--was it your intent to build your own for any long period, or was this a temporary measure because of the difficulty of getting the kinds of tubes you wanted?

ROCHESTER:

Well, we just did it because, because we had to. We had some physicists around that were, that understood how to do that sort of thing.

TROPP:

Mhm.

ROCHESTER:

And we just couldn't buy the tubes that we felt we had to have to make a practical memory.

TROPP:

Let's go back to the whole idea of memory. Thinking in terms of your radar experience during the war, the most natural kind of memory to have gone into would have been the mercury delay line. Because the technology, you know, related technology, and then you mentioned earlier the classified area and that was a drum type memory environment.

And I guess my question is really, did you consider other kinds of memories, and what ultimately led you to decide on the cathode ray tube?

ROCHESTER:

Yes. Well, yes, I even roughly worked, quite a lot of detail, worked out the architecture of a delay line machine. Earlier than the architecture for the Tape Processing Machine or the test assembly. It didn't seem as attractive as having parallel access.

TROPP:

Mhm.

ROCHESTER:

I mean the complexities of, of having to wait while this information circulated

TROPP:

Mhm.

ROCHESTER:

seemed like a bad thing if it could be avoided.

TROPP:

Mhm.

ROCHESTER:

And we eventually decided that it was possible to get parallel access, and that we'd make it, ... it would make it a lot simpler, and that that was the right thing to do.

TROPP:

Did you consider a drum memory at all?

ROCHESTER:

Well, yes. .. But .. the drum memory and then the revolvers, revolvers where you have a read head and a write head to get something that spins faster than any real drum. Yes. And eventually IBM did come up with a drum machine, the 650. Are you familiar with that at all?

TROPP:

Yeah.

ROCHESTER:

And that was very important. I have an anecdote about that which has always been a great inspiration to me.

TROPP:

Mhm.

ROCHESTER:

It was designed by Frank Hamilton, and the project was cancelled five times. [Laughter] A decision was made to stop the project and this would be the end of it. And .. he never gave up. In fact, I'm not sure that he ever stopped. An engineer has to do this sort of thing in order to win. It was very inspiring to see that example.

TROPP:

The 650 was a very important IBM machine.

ROCHESTER:

Yes.

TROPP:

There are two machines that I would like your comments on, that's one; CPC is the other. And this is in the realm of what I call, for lack of a better phrase, the computational environment. Introducing people to the fact that they could use machines to help them in various types of computation. And it strikes me that the CPC and the 650 in particular, did more in that area, in the early period, than any of the big machines. And I would like your reaction and comment on that in terms of what they accomplished in changing the attitude towards mechanical computation.

ROCHESTER:

Well, there was a, there was a whole tradition in a sort of branch ... learning, of skill, that had started in astronomy, in which people used punched card machines to do calculations. Have you ever encountered the--I guess it must have been McPherson, he would remember all about it, who did large scale scientific computations on an accounting machine?

TROPP:

Mhm.

ROCHESTER:

Okay. Well, sort of following that tradition, that's what led to the CPC, and instead of using an accounting machine they were using a 604.

TROPP:

Right. The 403 was the other--

ROCHESTER:

The 403 was a printer.

TROPP:

Right.

ROCHESTER:

And the .. and then there was a 604 computer.

TROPP:

Mhm.

ROCHESTER:

And you'd run a deck of--was there a sorter or something?

TROPP:

Yea, there was a sorter.

ROCHESTER:

Sorter or collator? You'd run a deck of cards through this thing, and you'd take it from one end and carry it to the other end and put it back at the beginning and run it back through again.

TROPP:

Mhm.

ROCHESTER:

And that's exactly, that's the same type of thing that McPherson did with his astronomical computations on an accounting machine.

TROPP:

Mhm.

ROCHESTER:

Just run the cards through over and over again. And certainly the CPC made this type of calculation much more accessible to a large number of people than the kind of thing that McPherson did. I mean it's too specialized and too arduous,

TROPP:

Right.

ROCHESTER:

and the CPC kind of mechanized a few parts of it, although not the card carrying part. So that certainly did that.

TROPP:

People became very ingenious in terms of how they used the CPC.

ROCHESTER:

Yeah. On the other hand, all the CPC people went over to large computers as soon as they could get their hands on them, I believe.

TROPP:

Yeah. Yeah. I'm not arguing the CPC was an end-all. I guess the literature tends to ignore the CPC in terms of having any impact. And I guess what I'm interested in talking to CPC users was the fact that it was a very important machine, because it was their first introduction. They would never have gotten, or some of them felt they wouldn't have gotten to the large scale machines if they hadn't gone through this exposure.

ROCHESTER:

Yes.

TROPP:

Not what they learned on the CPC as much as the exposure of being able to use the CPC to solve a variety of problems.

ROCHESTER:

Yes. Mhm.

TROPP:

And, as I say, I was interested in your comment on that.

ROCHESTER:

Yes, I think it was influential. I've forgotten about the exact timing that's involved, that must have preceded the 701, didn't it?

TROPP:

Yeah. In terms of actual delivery, yes.

ROCHESTER:

So the same people were using CPCs that later were 701 customers. And so the CPC must have been influential in making it possible for Hurd to come back with a report that he could sell six computers.

TROPP:

Probably all those six had CPC's, or most of them.

TROPP:

Mhm.

ROCHESTER:

I think that must have been a fact.   Okay, now the 650 was something else again.

TROPP:

Yeah.

ROCHESTER:

With the 650 it was obvious that it would be possible to build a good drum machine.

And, at least, I felt that. In fact, I guess I did have a design of a drum machine that preceded the Tape Processing Machine, and it just seemed to me that it was a very good thing for somebody to do. But I was busy with the 700 Series machines. Unfortunately, at the same time Frank Hamilton was busy in Endicott building this very practical machine. I mean it was a lot cheaper, and so it provided a little access to computing to a lot of people who couldn't afford the 700 Series machines.

TROPP:

There were lots of them as there were lots of the CPCs around. As I say, they tend to get ignored.

ROCHESTER:

Well, I think there were a lot more 650s than CPCs, weren't there?

TROPP:

There are a number of questions that have come to me in terms of the 701 that you might be able to comment on. One is a trip by John Williams, George Brown, Bill Gunning, perhaps others, from the Rand Corporation either late 1949 or 1950,

ROCHESTER:

Mhm.

TROPP:

to IBM. All I know about is the need for computational ability, and I wonder if you are familiar with that visit and remembered anything about it?

ROCHESTER:

These are people from Rand Corporation?

TROPP:

Rand Corporation, right. In late'49 or early '50.

ROCHESTER:

Right.

TROPP:

Now they eventually went ahead and built their own computer, the JOHNNIAC.

ROCHESTER:

Yes.

TROPP:

But I wondered if there was pressure from them on IBM in terms of their needs?

ROCHESTER:

Well the .. I think they were making, the people from Rand Corporation, were making their feeling well-known. .. And there were, there was a group of them that were formally or informally acting as consultants to IBM management at the level of probably Wally McDowell, and Ralph Palmer. In other words, McDowell and Palmer were asking the Rand Corporation people, "Does this stuff that Rochester and Haddad and so forth, are working on make sense? Is this going to be something that ought to be done, or are they just a couple of nuts?"

TROPP:

Mhm.

ROCHESTER:

And the Rand Corporation people were all very enthusiastic about it. So they were a big help in moving IBM management opinion in the direction of getting going with computers. That's the, that's the only effect I recall. I do recall the visits.

TROPP:

Back on the drum memory. I'd asked you earlier about John Lentz.

ROCHESTER:

Yes.

TROPP:

And .. some place I picked up the information that he was involved in a prototype general purpose computer with a drum memory that was called, and I'm putting this in quotation marks, I don't know if this is right, the "610 Autopoint Computer." Does that ring any bells with you?

ROCHESTER:

It has a familiar sound. I know he was working on a very small computer.

TROPP:

But it would have been a general purpose type machine.

ROCHESTER:

Yes. I don't recall the details.

TROPP:

Another man I wanted to ask you about was Bill Bell. Was he at any time connected with IBM as a consultant or anything, in any capacity? Does that name ring any bell?

ROCHESTER:

Yes. Oh, yes. I knew Bell at that time, but I guess I mostly knew him as somebody that I would see when I went to meetings.

TROPP:

Mhm. You don't remember any connection he had with IBM during the 701, 704 era?

ROCHESTER:

Did he work for a customer? He may have.

TROPP:

I only know of him in connection with Telecomputer Corporation.

ROCHESTER:

Yeah.

TROPP:

And .. the question came up as to whether or not he had any consultancy relationship with IBM in this earlier period.

ROCHESTER:

There were a number of people who were quite influential, who were customers. For example, Walter Ramshaw at United Aircraft. Have you encountered him?

TROPP:

Yes.

ROCHESTER:

And these people were very vocal, and they would say what they wanted. And if you wanted me to guess at the relationship that Bell has, at a very early time he was working for one of our customers on the West Coast--must have been the West Coast--

TROPP:

Right.

ROCHESTER:

and .. and was vocal about what they wanted from IBM.

TROPP:

Like Walter Ramshaw, Frank Wagner, you know, people's names--

ROCHESTER:

Yea, those are the type of people.

TROPP:

of the group. Another name I wanted to throw at you in terms of the 701 period was Ted Glaser,

ROCHESTER:

Yes.

TROPP:

who was on--was he on the 701 project with you?

ROCHESTER:

The 701 project was partly in Poughkeepsie. That was the engineering and production and customer engineering part. And Jerry Haddad and I were responsible for the engineering

TROPP:

Mhm.

ROCHESTER:

jointly. There was nobody, it was a, it was a two-headed organization,

TROPP:

[Laughter]

ROCHESTER:

there wasn't any one individual in charge of it. We just were able to cooperate well enough so that worked. Ted was in Cuthbert Hurd's group, in New York.

TROPP:

I see.

ROCHESTER:

They were concerned with dealing with the customers, and with providing .. what we would now call its programming systems support, .. such as it was. And .. it was quite amazing to see him program the 701, being blind.

TROPP:

Mhm.

ROCHESTER:

At that time he much preferred punched card, plug able machines, because he could feel the position of the plugs.

TROPP:

Mhm.

ROCHESTER:

He said, "When I design a program, when I write a program for a stored program computer, I essentially have a design in my mind the whole machine, whereas when I plug up a machine it's very simple because it's all right there. It's just what you do when you're writing a program for the 701."

TROPP:

[Laughter] Apparently he was an amazing young man

ROCHESTER:

Yes.

TROPP:

in that period. .. Do you have any ideas about where I might find out more about what John Lentz did; and that seems to have totally vanished. Do you know of any sources?

ROCHESTER:

Is he still available?

TROPP:

I don't know. I don't know. I just have the name and very sketchy information. If he's still available would you have any idea where he might be or how I might locate him, if he's still alive?

ROCHESTER:

Yeah.

TROPP:

He was connected with Watson Lab at one point.

ROCHESTER:

Right, he was, yeah. And this work was done ...

TROPP:

I gather it was done at ElectroData, but it might have been done at one of the IBM Laboratories. He went some place else to build the machine, but that may be totally incorrect.

ROCHESTER:

Well, I could, I could run it down for you but the way I'd have to do, would be to call different people.

TROPP:

Well, that's all I was asking. Instead of you calling them I was going to ask you to suggest two or three names for me to start with, I'll save you that trouble.

ROCHESTER:

Well, the difficulty is that--okay. No, what I would do, the way I would solve that problem is to go out to my files and I would take out of that a little book which is The History of the Watson Laboratory.

TROPP:

I have that book

ROCHESTER:

You have that?

TROPP:

Yes.

ROCHESTER:

And then, and then I would look in there and I would find out the names of some people who would be likely to, who are still around, and would be likely to .. have the information. And I would ask them and they would refer me to somebody else,

TROPP:

Mhm.

ROCHESTER:

and pretty soon I would find somebody who would know exactly who it is.

TROPP:

Okay.

ROCHESTER:

That's, that's how, that's how I would recommend.

TROPP:

So we would both start at the same place except you would be able to pick out names quicker than I would.

ROCHESTER:

Yeah.

TROPP:

Okay. So when you go through your files we might, you might suggest a couple of names

ROCHESTER:

Yes.

TROPP:

to start with

ROCHESTER:

Mhm.

TROPP:

out of that volume.

ROCHESTER:

Yeah.

TROPP:

This might be a good place to go look at those files.

ROCHESTER:

Okay.

[Recorder off]

SAMMETT:

All right. The question that I would like to hear answered, or at least hear some comments on is how the engineers viewed the importance, if they viewed it at all, of the software for the early machines like the TPM, the 701 and 702? It's obvious that in today's environment we recognize the importance of the software, and this has come about so gradually that I think it would be interesting to find out how the engineers viewed this initially, and see whether there was any way of pinpointing the trend and the initial conditions on this.

TROPP:

Thank you, Jean. I'll let you listen to the answer when you get off the phone.

ROCHESTER:

[Laughter]

SAMMETT:

Thank you [Laugh].

TROPP:

Thank you.

SAMMETT:

[Laugh]

ROCHESTER:

We were, we were concerned with software right from the beginning, because we realized that in some sense software was more reliable than hardware. That is, once you got it de-bugged it would stay de-bugged, whereas the hardware would wear out and deteriorate. Consequently, in the 701 we had programmed floating point, and programmed loading programs, programs to handle I/O, things that were later taken over by hardware. The first assembly program was .. written for the 701. Cuthbert Hurd's group was concerned with developing programs that would help other, would help customers use .. the computer. Douglas Aircraft developed software of a sort, to do matrix calculations, I think, yeah, to do matrix arithmetic. Could have built a machine to do it but--So I think we were concerned right from the beginning.

TROPP:

I think that was a interesting point you made about the relationship between the software and the hardware in terms of a life cycle, if you will. It's an interesting characteristic, or an interesting way to characterize it. How do you see this kind of thinking into other areas that came later? How do you see the evolution through the 704, 705 and on into the

709, and ultimately where we are today? Jean indicated kind of gradual development. I'm not sure that's--at least it doesn't appear to be so gradual to me.

ROCHESTER:

Well, the percentage of software in a software/hardware mix has continued to increase. .. And with the increasing complexity of software has finally come a situation in which software is now less reliable than hardware. .. And most of the, most of the bugs, most of the errors made in some modern computers are made by the software. This happens mainly when you get multi-programming is a big way, but it can be a very serious problem.

TROPP:

Do you see a possibility of a reversal of that trend? Namely, because of the increase in complexity of software and the level of current technology, to move back into the era in which this is built back in, some of this is built back into hardware. I am thinking of one particular computer that we can talk about later.

ROCHESTER:

There has been a steady flow of complexity from software into the computer and that, and that continues. I think that now that we've suddenly gotten to a stage where software is unreliable that more disciplined methods of creating software are going to control the bugs in it, so we will again be back in the state that we were before, where most errors will be hardware errors.

TROPP:

You don't see a trend then of, a possible trend of reintroducing some of the software into the hardware realm?

ROCHESTER:

Oh, oh, let's see. Well, I see a steady flow, in fact an increasing flow, of function going from software into hardware.

TROPP:

That's, I guess, this question of semantics now. Yeah.

ROCHESTER:

Okay, and in particular now with large scale integration, it becomes practical and economical to, to assign large portions of what has been software to hardware, and that, that's going to be done.

TROPP:

.. And you look back in, in the early machines, in terms of their operating in a binary as opposed to a decimal mode, and you look at the current state of technology, is that a desirable direction of would you have stayed in the decimal mode?

ROCHESTER:

I guess I still don't know.

TROPP & ROCHESTER:

[Laughter]

TROPP:

I don't know either. That's why I asked. [Laughter] I just heard some comments along those lines, ...

ROCHESTER:

But I'm certainly glad we made the 701 binary. Otherwise we would have been stuck with decimal. The question would have been answered and it would never have been possible to market a binary or non-decimal machine.

[End of Interview]