Computer Oral History Collection, 1969-1973, 1977

Interviewees: Byron E. Phelps and Werner Buchholz
Interviewer: Henry S. Tropp
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TROPP:

This is a continuation of a discussion I started with Mr. Byron Phelps and we are going to be joined by Mr. Werner Buchholz, is that correct?

BUCHOLZ:

Doctor.

TROPP:

Doctor Werner Buchholz.

BUCHOLZ:

If you hear anyone calling me Bucks, old timers.

TROPP:

Okay. I think we are going to start with the tape processing machine, is that right?

PHELPS:

If you want to and then we'll skip back some other..... Sure while Buch is here.

BUCHOLZ:

Maybe we ought to start with the test assembly because that's where I came in.

TROPP:

Right. The test assembly that you discussed at lunch. Yes.

BUCHOLZ:

Well, maybe I ought to repeat what I said then. As far as I recall, I joined the Company in August 1949 shortly, a few months after Nat Rochester joined it and Nat was very much

engaged in educating us on the question of stored program computers. He ran lectures. Then he began, I believe it was he, and of course he could be asked to identify this, but I believe he's the one who first thought of the idea of, for purposes of training of becoming familiar with the subject, of converting the 604 into a store program machine.

This was done by getting a magnetic drum from Endicott who were very much involved in the magnetic drum development over there. Mounting it on top of a 604 frames and putting drum weave light circuits on it and coupling it to a standard production 604 and bringing out additional lines to the 604 plug board. Wiring it actually on the plug board into the regular 604 circuit so as to decode instructions and cause other things to happen like add and decoding of addresses and so on.

That machine was designed in the Fall of '49 and built during the Winter I guess, into 1950 and laying [?] for a while as a purely, a test project, it was never designed to go into production just a haywire type of thing. Several programs were run on it, we learned a good deal and it was used also as a test bed for attaching devices like cathode ray tube, memories and tubes just for test purpose and magnetic tapes and this is where we really learned some of the computer technology in the laboratory.

TROPP:

What was the essential motivation as you see it now looking back for the tape processing device?

BUCHOLZ:

Well, I think the big, or the tape processing machine, you mean?

TROPP:

Yes, the TPM.

BUCHOLZ:

Well, it was felt that with its card feed and so on the test assembly type of thing was not very practical, although I think in retrospect, in might well have been, if we had thought a little highly about it. The thing that was most attractive was the idea of magnetic tape because of its enormous storage capability the fact that it didn't have to handle all the cards, you could. Rewind and go back and run the thing again. In other words you can put files of records onto tape. This was the big attraction....

TROPP:

Except that the magnetic tape technology was so crude at that point in time. When you say you could do these, they were really visions of what you thought you could do more

than realities weren't they?

BUCHOLZ:

Well, I don't think it was so far away. In practice it turned out to be a good deal more difficult then anybody had thought it would be but these are just usually engineering problems of working with a new technology....

PHELPS:

I think we are familiar with that. It's new technology and you don't know if it will work. But some things, I can look through my records, but we got the first magnetic, multi track head from Cook Electric. It was at least in '49. I'm sure it was in '49.....maybe it was '50.

TROPP:

It was that early?

PHELPS:

Yes, I can look up the record for you. I've got some references. I'm going out to Cook to look at it. But it was '49 or '50 and that was a twelve track tape head. They were using it for [?] recording of a parachute drop or something like that.

BUCHOLZ:

In any case, the big motivation from a product planning point of view, was to get magnetic tape. That was, of course you can't handle magnetic tape without electronics, because of the low level signals, so electronics was tied to that.

The idea of a computer didn't strike too many people as very exciting. That seemed to be an exotic gadget for mathematicians and a few select customers like the Atomic Energy people. I don't know whether you talked about Atomic Energy in those days, aircraft people maybe more to the point. So some people even talked about such concepts as putting magnetic tape on accounting machines which to the technical people seemed completely absurd a complete mismatch. The problem was one that people still have, they think of a computer, laymen still think of computers as machines that they value in mathematical formulas. Whereas, of course, most of the time any computer spends is what one would now refer to as housekeeping.

That was very much needed for tape processing. So it was felt that an honest to goodness computer was needed and this is what we set out to design. I think we started in late '49 it certainly was going by early 1950 and was called the tape processing machine.

TROPP:

This was yourself and Nat Rochester and who were some of the other people who were involved in that?

BUCHOLZ:

Let's see, Byron you were involved in that.

PHELPS:

Some of the time, I was normally in charge of the projects, as a matter of fact, but I....

BUCHOLZ:

I think Jerry Haddad was on it, wasn't he and Howard Ross.

PHELPS:

Well, Charlie Bash and Bob Cragell?) also. These are all, Howard Ross at the time was just a junior engineering coming on, so it was Bash and (Gragell?).

BUCHOLZ:

Yes.

PHELPS:

Whereas Buch and Nat were more senior planners at the time. Well, of course, Nat .....

BUCHOLZ:

You see, (Dunwell?) was very much involved in the planning of it. He was based in New York City, though he commuted at the (?) now and then. This gradually was developed into a store program machine with electronic, with cathode ray storage, since Williams tubes by then had made their appearance and we tried that out. But since the cost was very much a problem, it was thought and electronics was considered to be costly we tried to cut the cost down and make it a highly serial machine. It's completely serial by bit all the way through. The arithmetic was serail by bit, the tapes were serial by bit of course quarter inch tape and it was, as a result, rather slow.

The other thing that was done was to try and cut costs a little too early. In retrospect, people didn't know about the problems of, in this case, the design and reliability problems and as a result, and the machine was complex enough and when it was finally assembled it was extremely hard to debug. In fact, as I recall, the machine really, I may be wrong on this, but I have kind of a recollection, the machine only ran once for any extended period

of time. We wrote lots of programs and we tried to test them and we really only ran a decent program once and that was rather late in its cycle. If we hadn't been so conservative or so cost conscious too soon, and had poured a little more money into more safety factors, I think it would have been a successful machine.

We tried to design the product before we had any knowledge of how to go about designing a product and that's why the machine fell by the wayside. It just couldn't make it and also it's performance was too slow, so in comparison with the UNIVAC which was our competitive target, and so that's why it was redesigned into the 702 eventually when we realized that it was going 6 bits in parallel as the 702 did. It really wasn't any more expensive, but as you spend a few, a bit more money on registers to hold several bits in parallel, you greatly simplify the controls and it turned out that that was a much better compromise for the serial by character philosophy that [?] with the 702 later.

TROPP:

One of the comments that I got on the tape processing machine on the outside, and as you as somebody who is not in IBM and only saw it from the outside, was that they looked upon it as the hush hush project that was a smoke screen to keep outsiders you know, from trying certain things, because after all IBM was working on it. If they were working on it why should they bother. I notice you were shaking your head because I asked you this question earlier and I wanted to get Dr. Buchholz's..

BUCHOLZ:

It was a very serious project from our point of view. We thought we were learning something by, how to build computers. We thought of it as a product very seriously, but it meant it met a great deal of resistance from some people who thought there was no real market for computers. There was resistance within IBM because it was thought there was no market for computer-like products in the business world. That was very hard to overcome and therefore the final decision to make a product was not made until much later. Then in the interim the 701 project developed and that really cut the ice. Without it we might never have made the 702 project.

One of the things incidentally that needs to be straightened out in people’s minds is the sequence of events here. The 701 is the first computer, store program computer we announced. It was not the first one from the laboratory's point of view. The 702 in the sense that it was a follow-on of the engineering model which we called the tape processing machine, had an earlier start and the technology used in the 701 was an outgrowth of the mistakes we made and the things that people learned in developing the TPM.

So there is, a commercial market was really always first among people in the laboratory. That was our primary target. The 701 type of thing was a bit of an excursion into a limited market where the demand was a little clearer and where people, the customers

weren't as awed by the technological novelty and so on.

TROPP:

Well, to put things in some kind of perspective the TM project led, from a technical point of view, directly into the 702 but had an earlier impact than on the 701

BUCHOLZ:

No actually.....

TROPP:

Is that a wrong....

PHELPS:

Let me try. I think it's fair to say, Buch you disagree if you do, and you should but, I think you could even say. Let me go back further, you phrased several times a question that there was a conflict within IBM and I think really you have got to realize that the 7, the TPM started up as a development group to explore the idea of magnetic tape as storage medium and a machine to use that storage medium. Then, because there was a long commercial hang-up, we got a chance to do something and part of that group was split off.

BUCHOLZ:

In fact most of it.

PHELPS:

Most of it really and for a while it got to (?) because most of it was split up to build the 701. You can't really say it was a separate or a conflicting group. It was simply a Company decision that this came first and we had slowed down the TPM work. It still went on. We had slowed on the TPM work. It still went on. We had slowed on the TPM work and most of the key people who were primarily Jerry Haddad and Nat Rochester and the rest of them were off as sort of a separate group. We were working side by side, to build the 701.

BUCHOLZ:

As a matter of fact, I myself was on the 701 project from the beginning and it was practically the 1st of January 1951 until about the middle of '51 and then I went back to the TPM which then became the 702 project and continued the planning of that. But actually, I kept some, I kept my feet in both camps because I wanted to have a chance to

program the 701 once it started running, so I did have a chance to write some of the early 701 programs.

TROPP:

Back to this conflict, area. The decision to build the 701 looks different from where which ever vantage point you happen to be. Its original name, the Defense Calculator, gives a clue as to come of the impetus and that was the Korean War.

PHELPS:

Oh, definitely.

TROPP:

Yes. How would you characterize that impact in terms of the decision to build the 701?

PHELPS:

Well, I think, I don't see any argument with laying the facts on the table. It seems to me that there was a lot of controversy within IBM and I suspect (?) at the time whether there was any real use to build one of these big monsters. UNIVAC wasn't selling very well. They sold, they had troubles, as you know, in the beginning. The defaulted some of their contracts and had a lot of trouble selling other people.

Well, there was a lot of debate as to whether a thing like that could ever sell. Now what Palmer and I think Tom Watson and McPherson probably had a big hand in it, maybe Cuthbert Hurd by this time, I don't know just when he came in.

TROPP:

Cuthbert came in in '49.

BUCHOLZ:

He did, I think he did the preliminary planning to get customers lined up for the 701.

TROPP:

He did the selling job.

BUCHOLZ:

Yes.

PHELPS:

Well, I think all of those people were convinced that, you know, that there was a real thing that we ought to get into. It was going to cost but this time I think they really had some vision. There was going to be a market for computers of some sort. We have got to crack the market some way. Commercial men were not satisfied yet and if we had waited to get concurrence to build a 702 as it turned out, it would have taken us several years yet. There is this demand, as you mentioned, of people coming in and we knew about what the aircraft companies were doing. They were using CPCs. We knew their problem. If we could build a machine for their purposes and it won't be an IBM machine, it will be a defense calculator for this particular purpose. We don't have to go through all the commercial approval required. We can sell it on just this basis, we are going to build a few machines for a specific job, get them out and get the experience in the field.

BUCHOLZ:

I want to be frank about this. I was only a junior member of a rather small team at the time. As I recall it, the decision to drop everything, we had dedicated ourselves to make a computer for the commercial world and get out into the, compete with the UNIVAC which was ahead of us, of course.

At that point a decision to drop everything and go into this highly parallel high speed machine was kind of a blow. We thought it was all wrong. It was a terrible thing to be doing but we were told to do it and we got into it and after a while, of course, you do get interested in the subject and it did become quite a fascinating project. I think from the technical man's point of view, and the lab, this seemed like the wrong thing. I'm sure what Byron said from a management point of view, this was the rationale and in retrospect, probably the correct rationale. One can never know, but the chances are you would never have got going in time in the computer field if we hadn't used the need, the world market need, for a high speed machine, as leverage.

TROPP:

Well, in terms of the architecture of the 701, overall architecture, did the conceptual design come out of the needs of the aircraft industry as much as they did out of your experience with the prototype that you had in the Laboratory here in your experience to build the TPM, or were there other major inputs?

BUCHOLZ:

Actually, there is very little relationship, architecturally between the TPM and the 701. On the 701 we started with the so called, Von Neumann machine, the IS machine at Princeton, as a starting point and of course Whirlwind was well known and that type of background. The (power?) machines, the high speed machines. We tried to simplify these concepts to get rid of some extraneous quirks in the architecture and of course we never

used the terms in those days, it was called engineering planning. We tried to streamline the thing, to put in some improvements and in particular the most important thing that I think we contributed to it, other than to put the machine into production, which in itself was a major contribution, was to put some good input output equipment on it. Most importantly, tape, and also card readers, punchers and printers. UNIVAC had printers too but it didn't emphasis any good input ..... [voice fades out].

So this is the, cleaning up and making some improvements and I would have to think for quite a bit to remember what these improvements were. We did write some papers on it, so there is some documentation on the subject. It is very much in the style of the machines that started with the Institute for Advanced Studies.

TROPP:

That's interesting because that machine is inoperative until oh, what, 1952.

BUCHOLZ:

Well, they had their hang-ups, they did have problems.

TROPP:

They had problems. But there were copies of the machine already in operation. There were other verions.

BUCHOLZ:

Oh yes. We certainly can't, couldn't claim any novelty in terms of basic concepts. We thought we had improved the thing, but the main contribution was to get multiple copies into production.

PHELPS:

Well, I think there, if I can butt in for a little bit. We are talking about a different level. As a pure hardware man I'd say that the 701 really took the hardware developed for the TPM and carried it further.

BUCHOLZ:

You were asking about architecture.

PHELPS:

Detail. I'm saying that there was a detail there the level at which we really just took a, well it’s a new thing. So we [?] delay unit where it was best. We had a dial logic which

we had not done before. Dials were just becoming theoretically cheap. They were supposed to be 14 cents a piece but it was a long time before they came down to that. So that engineering wise it was IBM and conceptually it was a lot of people. Von Neumann and probably Wilkes, Wood. Williams had some basic concepts of the computers if I remember correctly, didn't he? We think of Williams as the Williams tube but ..... [voice fades out].

BUCHOLZ:

We certainly picked the indexing concept what he called the bee line.

PHELPS:

Bee registers.

TROPP:

Bee registers.

BUCHOLZ:

But not until the 704. That did not get into the 701. The basic thing we picked up from him was the storage concept and that one became a major engineering project, all in itself to try and make that work. The tubes were manufactured here, designed and manufactured here and also the regular little vacuum tubes were also designed for the storage tubes. Redesigned.

PHELPS:

The one thing we had in our favor was the 604 because as you will see when we get back to that. As far as I'm concerned, when we first started the 604 we couldn't interest any tube companies in making us a tube. By the time the 604 got into really good production then we had GE and RCA both building tubes for us. That made a hell of a difference because the early days of the 604 were plagued with bad tubes and we finally got them to build us some really good twin triodes and .....(voice dies out).

TROPP:

Did IBM, didn't IBM, I should say, at this point in time, consider going into the job of making its own Tubes? Or at least considering it. Didn't they start a small laboratory?

PHELPS:

We did. We had a small tube laboratory, well, sorry, we had a tube laboratory in '41, '42.\

TROPP:

Where?

PHELPS:

In Endicott. We were able to make tubes. Very small, wasn't two (million?).

BUCHOLZ:

I think the Williams tubes were definitely designed and made here.

PHELPS:

Not originally Buch. They were originally made by RCA, but RCA got so small for the TV that they weren't giving us the attention they should have. That's probably not fair, they just, they were stuck. We were buying a few hundred tubes a year and they were trying to sell millions of TVs tubes and you know who got the emphasis. We did eventually make our own. We had a tube (vine?) down on the plant and made our own memory tubes.

BUCHOLZ:

But now on the logic tubes, if that's the right term, I thought the work was done on the reliability of these tubes and redesign of existing tubes and then laying down the specifications. They were not manufactured here. But they were manufactured to IBM specifications, and they had IBM numbers on them.

TROPP:

Well, you've raised a couple of peripheral questions I'll insert at the moment. If they're not relevant, just ignore them. You mentioned Williams work and of course that brings to mind the computer that he and Kilburn built at Manchester. Wilks had a machine going at Cambridge. There was a computer at the National Physical Laboratory. There was the Lyons Tea Company that was trying to build what eventually became Leo and I guess from the standpoint of technology and others areas what would you say your input was from the English environment?

BUCHOLZ:

Technology. Well, I.....

TROPP:

You mentioned the Williams tube as a.....

PHELPS:

If you're talking about hardware, probably the Williams tube is the only thing that we got from them. I think we were, I don't know, I think we were probably ahead of them in reliable tubes, reliable components, we had a lot of..... I could tell you a story about resistors for example, which happened to be one of my fields, I got involved in. There was only one company in American that could make resistors that could stand up in computers for many, many years. It's unbelievable, nobody else could, and I don't quite understand, yes I do understand, but that's a long technical question.\

TROPP:

What was the Company?

PHELPS:

Allan Bradley.

TROPP:

Allan Bradley.

PHELPS:

We tried other brands and tried other brands and you can have this but don't make it public, I don't think it would be fair, but until (sage) came out we never had another resistor that would stand up.

BUCHOLZ:

These were molded, weren't they, isn't that the reason?

PHELPS:

The way they were made, ...(voice fades out).

TROPP:

How about from the standpoint of concept. For example, one of the concepts in England was the early machines, for example, was to design at lower speeds and at a more reasonable engineering level than some of the American products were shooting at, and as a result they got on the air earlier. Did that have any impact on you?

BUCHOLZ:

Well, I think this is only true of the university type of machines. I don't know that there's any production machine.

TROPP:

No, no, no production machines.

PHELPS:

Well, I think we were held up. There's no question about it, but we designed everything to the best of our ability to be over safe.

BUCHOLZ:

After the first experience with the TPM.

PHELPS:

Oh, I think even the TPM theoretically was, we just didn't make it in plenty of places, Buch. I think everything we did, we never used a tube at more than half its rated capacity for example, power or something like that.

BUCHOLZ:

By the way, the Williams tube, maybe you have already been over this, was the second thing we tried. We tried the RCA's selectron and I remember Charlie Bash had one of the enormously expensive tubes on his desk for many years but that tube was, I don't know what the problems with it were, other than cost.

But people then tried the Williams principle which was just much more tricky because of the low level signals you had to pick up, but eventually when the problems were worked out that turned out to be the much easier thing to .....(voice fades out).

PHELPS:

I think I can answer, you may know the answer too. The fact is that RCA never did really deliver the tube they promised, and I think they had trouble (?) it turned out to be uneconomic. Or Williams (?). I know they, we had some early tubes but they never delivered the kind, the density they were going to get or the reliability they were going to get.

TROPP:

What you are saying is borne out by the Von Neumann machine at Princeton was originally supposed to be built with selectrons and because of similar problems it ended up using the Williams tube. So I'm sure that's pretty accurate. Although later I gather there were people who felt the selectron could have been made to perform properly with a little bit more work.

PHELPS:

Today it probably would.

TROPP:

The circuitry would have been much simpler with the selectron as I understand it then what you eventually ended up with in the Williams tube.

PHELPS:

I think that's probably fair but to say you could design the Williams tube today to be damned reliable I'm sure.

TROPP:

Well, somebody made the comment that by the time you were ready to build the 704 the Williams tube was sufficient reliability that it would have worked perfectly. The customers had long learned the old, heard the old stories and wouldn't stand for it.

BUCHOLZ:

Well, it wasn't just the customers. It was our own management.

PHELPS:

I'm bringing out my whole (morgue?). But that's the barrier grid tube. That was an IBM development and that probably was....

TROPP:

I'm sorry, would you name that again.

PHELPS:

The barrier grid tube.

TROPP:

The barrier grid tube.

PHELPS:

The barrier, it's the Williams principle, but instead it's got and I don't remember any more, its so long since I looked at it, but it's got internal storage services designed for the purpose. Designed solely as a storage tube. But I think this probably would be close to in order of magnitude more reliable than the Williams tube, but it came too late.

We actually built it in an experimental sorter. That's the only machine it ever went in. The only reason I have it, is I had not been able to find and IBM built 701 tube which I tried to find for a model, but that is an IBM built tube. An IBM designed and built tube.

TROPP:

About a year ago, I just discovered this, but until about a year ago, some place in the Mid West there was a 701 still running.

PHELPS:

I have been told there is.

TROPP:

It business. In fact the inventor who invented it made it the most money because he got paid as so much (?). But when we first started the TPM the very first thing we built was a tape sorter.

BUCHOLZ:

Built or programmed do you mean?

PHELPS:

Pardon?

BUCHOLZ:

You mean we built or we programmed?

PHELPS:

Well, I'm not sure. It's probably after the test assembly but it was before anything else for

the, because that was back in the days of the quarter inch tape. I can remember Joe.....

BUCHOLZ:

That's right. There was a, yes there was Sochor's. I am very hazy on that.

PHELPS:

I can remember because the darn thing ran at 200 (?) per second, it had a high speed rewind. Every once in a while something would go wrong, and that rewind would start going and little pieces of tape would fly all over the room and in the air and Joe Sochor would cuss. [LAUGHTER]. It really was firm. You didn't leak what was being developed in the lab until they decided to announce it. For a lot of reasons. Salesman loved to find out because they wanted to give their customers the latest poop from IBM and they tried to get in the Lab and find out even then and we very jealously guarded it. We didn't want one salesman to get advantage over another salesman for example and so until we got the machines like today when you have to tell the customer a year ahead so we can start planning for it, we literally did not announce the machine until, well I guess we did announce the 702 and the 701 before they were delivered, but we didn't announce if for some period of time.

TROPP:

I don't know whether it's the 702 or 704, but there's a very famous story about one of the conferences. Maybe it was one of IBM's symposia or similar conference in the same time period, where there were two papers on the machine that had not yet been announced. The papers were withdrawn but they still appeared in the table of contents. [LAUGHTER].

BUCHOLZ:

The pages are torn out of all the copies.

TROPP:

Right. [LAUGHTER].

BUCHOLZ:

At one of the (?) computer conferences. I don't remember which machine that was.

PHELPS:

I heard the story too, but I don't remember the machine.

TROPP:

It's either, I've got the story accurately from Cuthbert Hurd including the documents and the table of contents and I've just forgotten, for the moment, the machine.

BUCHOLZ:

I'm sure I've got the volumes and if I were to dig I could find the same thing, I can remember that.

TROPP:

But that indicates the accuracy of what you are saying. To the person on the outside though it looks very much like a deliberate attempt to do other things.

BUCHOLZ:

Well, IBM of course, has always pursued the philosophy of announcing a machine sometime twelve to eighteen months before delivery and it was often a working engineering model of sufficient internal evidence to satisfy a product test department. So they, the 701 was indeed announced a year ahead of delivery. The same with the 702 which was more than a year ahead of delivery. So these machines were announced before they were completely ready but that was a standard IBM policy.

PHELPS:

But you couldn't talk about it until they were announced. In fact, just one minor correction. The 701 I suspect, was the first one because the 604, you see, the production line was set up and running before it was announced. The machines that were shown were off the production line. I was always true to the old hardware machines.

BUCHOLZ:

I see.

TROPP:

You had some interesting comments on the 702 and it might be worth repeating some of them on the tape here. We started off our discussion, for example, on the lack of compatibility of the tape unit on the 702 with that of the 701.

BUCHOLZ:

Well, I think that there the main point was the 701 tape drive preceded the 702. The 702 tape drive was a first one and it was engineered to go into production. It had the

preliminary tape drive on the TPM which was a quarter inch tape and serial by bit and obviously we needed something faster and we decided to go to a parallel seven track, six bits plus parity approach for the 701.

PHELPS:

If I may correct you, because we really did go the parallel tape before that because you remember the old (High Street?) 701, I'm sorry, TPM model with electro statis tape drives. Do you Palmer's edict that we were going to have electro static tape drives. Have you forgotten that?

BUCHOLZ:

Electro static? You mean electro static (flush?).

PHELPS:

Yes sir. When the winter came they didn't run unless you opened the steam valve on the radiator because they wouldn't work.

BUCHOLZ:

I don't remember the details.

PHELPS:

I'm sorry. My point was that we went to parallel tape before the, before the 701.

BUCHOLZ:

But in any case the 701 tape drive, the type 726 as I recall,

BUCHOLZ:

But in any case the 701 tape drive, the type 726 as I recall, was designed for the 701 as part of the 701 project before there was any decision made that the 702 would go ahead. The 702 during much of the two years of 701 was in development, was on the back burner. But Bob (Cragell?) and Charlie Bash being the only two engineers on the project, maybe they had a technician to help them but that was not properly revived until maybe sometime in 1953, or perhaps '52.

But in any case, there were enough drawbacks with the 701. The main thing was really that it did not measure up to the UNIVAC tape drive. As I recall the 701 tape drive was at 7500 characters per second. The UNIVAC, I think was something like 10,000 or 12,000 characters per second and we decided to double the speed and or density. Anyway, we

ended up with 15,000 characters per second, I think was the model type 727 which was the one they got into the 702.

So it was redesigned, it was, we learned a lot of lessons from the 701 tape drive and made a much better one.

TROPP:

I guess the question then is still valid and that is even though you were designing a much better, from the standpoint of lessons learned, tape drive for the 702, was there any consideration, if there wasn't why not, to making it compatible so that you could replace the inferior tape units on the 701 with this much more efficient and much more technologically advanced one that you had on the 702?

BUCHOLZ:

Well, that's two separate questions really. One question is why wasn't the tape format on the 702 tape drive identical with the 701 tape format so we could have interchanged tapes at least.

TROPP:

No, not interchange so much but knowing you were pushing the state of the art further, designed it in such a way that anybody who wanted it could replace the old unit.

BUCHOLZ:

Well, the answer to the first question was that, just to finish that thought was that we had no thought that these two would ever come together in the field. The 701 seemed to be destined for one set of customers and the 702 to a completely different set of customers....

TROPP:

That's an important point; that's why I asked the question.

PHELPS:

(There was no interest in our standpoint, I think, it boomed?).

BUCHOLZ:

That's the reason why we weren't thinking back then in terms of interchange type of compatibility. But now as far as operating the 701 is concerned, it was a limited program. It had been decided right at the beginning that 18 machines would be designed because we could see 18 customers and then a 19th one was put in as an after thought, I think are

correct.

That was going to be the end of the 701 project. After that we would go on to a commercial type project. So there was no incentive, at least I think there would have been a good deal of resistance to try and modify existing 701s to upgrade them. Because they had already been sold and they were on rental, but still we weren't going to spend a lot more development dollars on a machine that was essentially finished, as far as the Lab was concerned. It is true that way, considerable later, many of the 701s were upgraded with more storage, with more memories instead of electro static memories and so on, but that was well after the 704s were out, at least around the same time.

TROPP:

You raise a question that was, the reason I brought it up again was, a question that came up during lunch and that was this view of the scientific and the commercial computers as totally different worlds and the lack of bringing the two together even from a technical point of view.

PHELPS:

Well, be careful, you see we are talking on the level of technicality. I suspect the tape drives were mechanically almost the same.

BUCHOLZ:

Which, the 701 or the 702. I don't believe so. I think, well there may have been lots of common parts but physically they looked quite different. For one thing the 701 tape drive has two to a box and if I can recall, or someone may recall during lunch, we had a lot of electronics on the tape drive and we made the decision on the 702 to take the electronics out.

The reason for that was, in part at least, that we had in mind making some control units that would serve a dual purpose. One is to attach the tape to the 702 main frame or else a phrase we used in those days, an arithmatic and logical unit. The other was to allow it to go to card readers and printers. In other words we would have a tape to card, a card to tape, a tape to punch and tape to printer unit as an off-line auxiliary unit using the same control unit and we would have a few additional circuits. We would put both the card or printer unit electronics and the tape electronics into the same control unit.

That appeared to be saving us some money. That might not have the way it actually turned out but that was the philosophy behind it, that we would have the single set of control units, that's multiple purpose and we take the electronics out of the tape drive itself. So there were a lot of differences between these two tape drives. Maybe not so much from a technology point of view but from the way they were designed and packaged.

There was one particular controversy that occurred in those days, when the 704 was being engineered, and the successor to the 701. We were going to use 727 tape drives, the new ones, on it. We had a battle on the parity bit. That is the so called commercial, the 702 people wanted an even parity bit because they insisted that we need to have at least two one bits on each tape, on each character, each tape frame, so that if one gets lost we would still have an indication that there was an error there. Whereas if both got, if everything disappeared then we wouldn't know the character had even been there. Whereas on the 701 which was a binary machine, or 704 I should say now, which was a binary machine, it was necessary to have all 64 combinations of 6 bits available. That required an odd bit unless you were to have a luxury of having some combinations without checking which was not acceptable. This battle raged a long time, as a result we had designed the 727 both ways. We ran an add parity on the 704 and with even parity on the 702 and later the 705.

PHELPS:

I can smile, he's being very polite. Because at the time he blamed me for the even bit on this. [LAUGHTER]. (I did too, for not being consistent?) (LAUGTHER).

BUCHOLZ:

This was just one of the many aspects of dichotomy between so called scientific and commercial markets. After a while some of us realized that the distinction was quite artificial. That there were many customers that had both engineering jobs and data processing jobs within the one roof they needed only one computer but they couldn't properly do both jobs on the same machine the way we marketed them. We put (FORTRAN?) on the 705 with great reluctance and then it wasn't very fast because of the nature of the machine and we never did put much data processing software on the 704 type of machine for many years. So we really made it almost impossible to do both types of jobs on one machine even though in a strictly technical sense they were both capable of doing more jobs. Some of us were beginning to push in 1955 and 1956 for dual function machines. In particular also, recognizing that even so called commercial customer, most of the time is doing things that are of housekeeping nature where you can't really distinguish what is computing, what is data processing.

The same thing with a scientific customer. He also does a lot of housekeeping and only occasionally he multiplies. So the two should have come together long ago, but the battle continued to rage until it was finally resolved with the 360. At that time, only by a kind of managerial edict. There were many people who were not really willing to recognize this as a fact until the 360 in the field demonstrated the need for it.

TROPP:

There's a name that I wanted to ask you about that hasn't come up in our discussion, in

connection with the 701 and that's the physicist Ted (Laisser?). Was he on the 701?

BUCHOLZ:

Well, now, let's see.

PHELPS:

He was around about that period of time. No, a little later.

BUCHOLZ:

I have a very poor memory for some of these things. I know he worked for me for a while, but I don't remember what project we were on at the time. I remember Ted very well as being one of the few, maybe the only person, that I ever knew who could write programs that would work when they got on the machine. Because being blind he could devise them in his head. He had an excellent grasp of all the various machines that we were involved in. I guess he was really involved in most of the projects while he was with IBM in the Poughkeepsie (protege ?) in some way or other. I have trouble pin-pointing the dates and therefore the machine projects we were on, doing some research. Ted, having a good memory, would remember this much better than I.

TROPP:

Is he still at Case Western do you know?

BUCHOLZ:

I believe so.

PHELPS:

(I haven't heard in years?).

BUCHOLZ:

I think he's in charge of the Computer Science Department.

PHELPS:

He did not have a major position but that doesn’t mean he didn't make major contributions. I know he was around and I remember him but I can't ....I dug these out. It's interesting. I think the 701 wasn't even firm when they printed this manual because it doesn't specifically say state tapes (?) or density, but if I figure right, it's 200 words per foot and I figure that's 100 bits per inch. Whereas the 702 was 200 bits per inch and .....

TROPP:

That fits with what he said just now, double.

PHELPS:

Yes. Just about. In fact there's, if you want to see, those were the days when you could sing on tape. [LAUGHTER]. If you knew how to do it. [LAUGHTER]. Did you go to electrical school. You never used the (?) technique for studying (magnitude?)?

TROPP:

No. [LAUGHTER].

BUCHOLZ:

It was called developing tape. It was a (?). I have the filings on it.

PHELPS:

There's a magnified photograph. In fact, we got into a debate about TPM code at one time and I used to look at one of these things through a microscope, but that's what this is for. I had these blown up so I could study them to establish the code that was on there. [LAUGHTER]. Buch.....(voice fades out).

BUCHOLZ:

Byron and I had battles on several subjects [LAUGHTER], battles..... (voice fades out).

PHELPS:

I did it with all due respect, because you looked at it from one view point and I looked at it from another one.

BUCHOLZ:

Well, one of them, being the subject of the separate sorter, collator idea which, at one time at least, was destined to be called the 703 except it never got announced as a regular product but many people wondered where the 703 disappeared to in the 701, 702, 704 and 705 series. There was..... (voice fades out).

PHELPS:

..... What happened to the 703? Everybody seems to want to know that.

BUCHOLZ:

Yes. Well, you probably need two versions of that story, namely Byron's and mine. I will give you my story as best as I recall it at this point, but in the 702, 705 area, one of the biggest time consumers, at least the ones we could identify, was sorting. Sorting was being done on cards and we were always displacing obviously, card installation. So people were used to card sorters and it was an isolated thing and this was quite a well defined technique where people were doing this thing and in a really short period of time compared to all of the other cards processing steps, that you go through. When we developed sorting programs for the 702 and 705 they really took a long time out of, somewhat out of proportion to all of the other things that we were doing, or that people had to do with direct analogue with the card operations.

So the question naturally arose, well the question rose anyway, that can we not do better with designing a special purpose machine for sorting and collating rather than using the big cumbersome computer, you don't have to multiply when you sort. You don't have to print when you sort, so lots of things, presumably, can drop out. There were two schools of thought on that. One said yes and the other said no. I was in the no school on the basis that....

PHELPS:

He turned out to be right, which often he did.

BUCHOLZ:

On the basis that we did have a general purpose computer that most of the functions that you need to do sorting and functions that you also need in general function computer, and if we fall short somewhere, we ought to have design improvements but that would benefit everything and therefore we ought to come out with a better machine. But the 703 probably was developed and I'll let Byron give you some of the details on the thing. It really wasn't resolved until the 705 finally came along. We could figure out probably how long it would take to sort on an improved machine. Can you describe the 703 project at all?

PHELPS:

Well, if you want it very simply. We simply made a merging tape sorter. The plan would be to have four tape drives and just enough..... I can't tell you about the second model, Max (Hermer?) built that. The first model I built with Joe (Soaker?) and Art (Cusnik?), but we had, I don't remember the capacity, we had four memory cores, I think, on top of the thing, and we going to have four tape decks. What you would do was, you would make multiple passes. You would merge, the first time you would..... Well, you'd read

one tape and as long as it's in ascending order you would transfer that data directly to another tape. As soon as you got a lack of order then you would fit that to tape B. If you had this merging technique. I think it's an old sorting technique. I'm not really a sorting expert any more.

All you did was you, to start out you take what ever is on one tape, I'm sortty, data or words that were in order, transfer to the other tape. Then on tape two you take the next load which might be lower. If you did this logically, then you, as soon as you have something above the first row, I'm not making much sense, you would start..... Anyway you would build sequences. I guess I can't say it any better then that. I can give you.....(voice fades out).

TROPP:

You build sequences until you are able to fold them together.

PHELPS:

Well, every time you went fewer you got bigger and bigger sequences. That read just enough memory to.....

BUCHOLZ:

That was essentially the same process that we would program on the 702 as well.

TROPP:

I know one of the big projects at UNIVAC was to build a sub routine.

PHELPS:

I think they had one. The other thing that also we had in mind was, and the name of the second machine was a file maintenance machine, was that very often you only put on one or two records. I've got a big tape file here. I just want to find buckles. So rather than put it on a big TPM I would put it on a sorter in the corner and I'd just run it until I found buckles. Well, it might be a small order, I might want to give buckles lots of drop and I'd run those (?) and I'd come out with a tape with that data on it.

BUCHOLZ:

Well, that of course, is a constant argument, even today, the mini computer versus the general computer with the more terminals question is the same type of thing. Can you do better with a stand alone specialized thing or maybe preprocessing and coupling to the main computer to relieve it of its burden. Or would you do better to design the central computer more efficiently because you ought to be able to, it's cheaper by the dozen, you

ought to be able to get a pay-off by loading it up as much as you can. And still somewhat of the same school, although I think there's some school.... It can do better even when it doesn't always do it.

TROPP:

I think if you gather ten people today you would find five on each side of the question, if you did a pretty random gathering.

BUCHOLZ:

I would like to go back a little in history on this question of sorting. Because it's a fascinating subject and I'm not sure how one establishes the facts on it. We were well aware of the sorting problem even back on the test assembly in 1949. In fact, as I mentioned during lunch time, I brought a little sorting program which was very impractical but it demonstrated the principle. By reading all the cards into a drum and sorting them on the drum and punching it out again naturally. There was no practical application with the limited capacity on the drum, but it showed just how you would sort internally to a stored program computer. So, this was always a big question, but the thought was we had these card sorters with how many pockets do they have. Basically ten pockets, plus a reject pocket, I guess. That's eleven, I don't know what the twelfth was for.

PHELPS:

There was twelve holes in the card and you..... well for alphabetic you need all twelve holes anyway, then you had a reject besides, thirteen pockets.

BUCHOLZ:

Okay, thirteen, fine. But basically for numerical sorting, let's stick to that, you need ten pockets. So you sorted into the ten pockets and it pulled out again, you put the cards back in the hopper and you start on the next column. Well, the natural thing to do is to repeat the same thing with tapes and that's what we thought of. But ten tapes, in fact, you really need twenty, because putting all tapes together.....What you really needed was twenty tape drives to do the thing efficiently.

First, you spread it over one set of then and then you put in on one after the other, after the other any you go onto the other . Now maybe, you can simplify it a little bit by having eleven an circulating around or something, but there, but need a minimum of ten plus tape drives to use the same technique as what was used for card sorting. That was of course, very expensive as well as meaning a lot of tape handling.

People were always wondering, now what can we do about this? Somebody said he had heard and this is the way I recall it and the story may have go modified in the retelling, it

may never have been really true, but the way I recall the story was, one of our planners from New York and it may have been Dave (Woolwich?), I'm not sure, came out with a piece of intelligence that UNIVAC had developed a way of sorting with core tapes. Saving a lot of money and a lot more efficient and he scratched his head and couldn't figure how the heck they had done it.

He sat down for many days and finally hit on the bright idea and that bright idea was to use a repeated merging technique. Because we knew of the merge, we had written merge programs, but to use the repeated merge, the same thing that Byron described earlier, is to keep merging sequences and going back and forth until they go in a single sequence. So we thought, well that's a fine idea, we programmed that on the TPM I believe and that was then our basic sorting technique. It wasn't until quite a bit later that I discovered to my surprise that the same technique is described in the original Von Neumann volumes. [LAUGHTER].

The third volume was so hard to read, I never had looked at that.....(voice fades out).

TROPP:

You are talking about the collected works?

BUCHOLZ:

Yes.

TROPP:

The Von Neumann collected.....

BUCHOLZ:

So called, the description of the store program machine they published....

PHELPS:

The works on that came out years ago....

BUCHOLZ:

The Von Neumann volume, 1947 I think they were published. I think there was a 1946 date and a 1947 date.

PHELPS:

That's another. I'm not familiar with that.

BUCHOLZ:

Well, that's a standard series that's being pointed to in the history of store programs. They subscribed this merging technique, at least (for a memory?), sort. None of us knew about it. In fact, I wonder, you mentioned earlier how few people read those papers in those days at the time they were written. I wonder how many people really read about it. In addition to that I heard the story that the rumor about UNIVAC was false. They didn't have the four tape sort. So I don't know....

TROPP:

At that point in time they didn't, as far as I know.

BUCHOLZ:

It may very well be that whoever this person was and I'm not sure I ought to credit Dave (Woolwich?) with this, ...

PHELPS:

Could have been him. He's quite....(voice fades out).

BUCHOLZ:

Somebody thought he was re-inventing something, when: (a) The thing he was re-inventing didn't really exist and (b) When he was in fact re-inventing something they had never even heard about. I think that Von Neumann's, or whoever was responsible for that one, that original volume described, what was it five years earlier? So the way we got started on this merging sort was always an intriguing thing to me and it might be interesting to get ....(voice dies out).

TROPP:

I may be wrong in the time, but I think the sorting routine as the UNIVAC people called it, came after they were taken over by Sperry Rand which was after '53.

BUCHOLZ:

Oh, well I'll have to look....

TROPP:

I don't know the details of it. I don't know if it's a four tape merging method or not.

BUCHOLZ:

Unfortunately, my first note books with the company were destroyed some years ago accidentally, without my knowledge. So I don't have a specific, the chronological records but I may have a few references I can dig out. I don't recall exactly what I have on that.

PHELPS:

How was Joe (Soaker's?) (theory on ?). Do you remember, that was two tapes?

TROPP:

Joe who? Sir.

PHELPS:

Joe (Soaker?). Probably not pertinent to your field, although he was around IBM for a while, but ....

BUCHOLZ:

Sochor.

PHELPS:

I was going to say that on the strength of your comment on sorting to begin with, in the old time card days the sorting machine was probably the most important single machine in the whole….

PHELPS:

But I don't remember how it worked. There were two tape drives and one of the things - there was direct translation. I don't know how we did it because one of the things we were worried about was how could you translate from one tape to the other with a buffer in between and we never did solve it of course because we've got buffers, but....

TROPP:

I guess another one of my general questions is, you mentioned the chronology of the 702 essentially preceding the 701 in terms of ….

BUCHOLZ:

First engineering effort.

TROPP:

First engineering effort, and I guess the next questions are then in terms of what you learned on the 701 that ended up on the 702 and how those two experience contributed to the 704 and 705?

BUCHOLZ:

Well, the 702 took over essentially the same technology. The same pluggable units and basic construction and the same Williams tube and storage technology.

PHELPS:

About the only construction difference was that we decided that it wasn't worth the bother trying two different storage elements, basic elements, and we did away with the (Haven's?) delay line. The 702 was also [?]. The theory was standardization.

The 701 used, oh, in shift register the (Haven's?) delay line was better, it was simple and logical and I don't think we used shift registers in the 702 in the same sense. It was one more kind of device that the customer didn't have to worry about so we abandoned that. So I think, that otherwise it was one logic, the same type of study, same type of flip-flops, buffer units.

BUCHOLZ:

The 702 as I mentioned earlier, of course, was a completely different architecture. In addition to that we put more emphasis on input, output again, or did we?

PHELPS:

Well, another big first I think you ought to mention was Nat Rochester's variable word length and I think that came out very early in the TPM. That's probably an IBM first.

BUCHOLZ:

Yes. There were differences in the architecture. One of the reasons these machines were serials, it allowed us to mimic the variable (feel?) length on cards. When we had a (?) number of six columns followed by a quantitative feel of three columns, followed by maybe an alphabetic name of twenty five columns. That type of thing you can do much more readily when you go character by character then if you have a fixed word length as the 701 had of 36 bits, that was this unit's operation.

Now the way we did it on the TPM was different, though we used I think, oh, I don't remember the details of that. We used markers to deliver the (fields?) and ....

PHELPS:

End a tape and start a tape and feel mark was the end of the record.

BUCHOLZ:

We had ways of limiting the (feels?) in memory. We knew what started them and then the machine would go on until it found one of these marks and finished. The 702 used a somewhat different version of that. Basically the TPM and then later the 702 and (?) pioneered the variable (feel?) length concept which was then continued in the 1401 and of course, was also to some extent, in the 360, 370 in character mode.

PHELPS:

I think the real difference in the 702, except the architecture was entirely different, they were aimed at different thing, different code, different everything. The other thing was, we simply took the 701 engineering and refined it. There were improvements in many regards that we had done with the 702. Any improvements we learned in circuitry we added.

TROPP:

How about the impact on those in the 704 and 705?

BUCHOLZ:

On the 704, as I recall, and then you really ought to talk to Nat Rochester because that was his and Jean (Androph's?) (baby?) I recall. Jean worked for Nat in those days. It was sort of an under the table project. When the 701 was finished we delivered our 19 machines and who wants any more? But they were already aware of the fact that there were some flaws in the thing. One was it did not have floating point arithmetic. It was well known it was being programmed in subroutines and they were busily designing a 701A or whatever it was called with built in floating point. I believe, and this needs some checking, I believe they used the CPC floating point routines as a prototype and naturally built them into hardware.

The other major change they made was to put an index in and there they took their cue from William's bee line..... bee box, I guess it was called. It was a line on the tube that was a I think called a bee line, there was an index register. So there were index registers built into the 704 and of course the instructions format was revised because they decided that the half length words, we had in the 701 of 18 bits wasn't (?), the instruction bits were less then for something else, so it became a 36 bit only machine and there were several refinements of this type.

PHELPS:

Core memory was the ....

BUCHOLZ:

Core memory was put in, that's right. That was of course the most visible change in many ways. A whole s of instructions were put in because they were very close to the 701 customers and they listened to all the complaints and they invented solutions to each, I think probably over did it a little. There were too many ad hoc instructions on the 704 that were carried all the way through the 709. In fact more were added later I believe.

And so some of the nice clean design of the 701 disappeared in the process. I am not saying this in a critical fashion. The 704 was a much improved machine. In addition they used the 702 in [?] here. The 702 tapes, the 702 parameters [?] punch printers. That part of the line was merged, except for the need of changing the parameters on the 704. So that was kind of done, largely under the table but as I recall, it was practically finished before the decision was made to go ahead with ....Knowing it was there and all ready to go and no more investment necessary, the decision was much easier.

TROPP:

What kind of decision was involved in deciding how many 704s to produce? There was the 701, there was a fixed market long before the machine even existed. The 704 grew up in a totally different environment. Who made the decision, for example, yes we'll go ahead and produce the 704 and how many of them are we going to make?

BUCHOLZ:

I'm not sure. I think .....(voice dies out).

PHELPS:

(?) might know. Yes (?) might know.

TROPP:

I got the feeling in the early days the decisions of that sort were made by the accounting department.

PHELPS:

Pretty much. The sales, the sales ruled the Company.

BUCHOLZ:

Yes. Well, there were market forecasters and planners and in the scientific end, the applied science department which Cuthbert headed for a while was really the planner, Planning Department, they made a lot of the basic decisions.

PHELPS:

I think Keith [?] probably had enough customers lined up saying we want something better than the 701, that he went to management and probably found out that Nat had worked on it and got them to agree that, probably built a few. Our experience generally is that we probably planned for...(voice fades out).

BUCHOLZ:

I don't think there was a termination date set on it. The really important thing about the 704 is that this is one of the instances where we were ahead of the field. We weren't rushing after a competitor. This was actually a better machine than most of its competitors. I guess there was some significant competitors around, but it really came out in plenty of time. Whereas the 702 was struggling with being behind the UNIVAC and you will probably recall probably by reading Fortune magazine, that what a struggle it was to catch up and that the 705 was born in a panic mood under Mr. (Learson's) guidance. That was really just an upgrading of the machine in some significant respects and not a (compatible?) upgrading.

TROPP:

I see.

BUCHOLZ:

Then of course, after the 705 came out, things went pretty smoothly for a while. The 705 model (came?), the 704 evolved into the 709 and so on.

TROPP:

I want to get to a difficult question and it's really addressed to both of you and that is referring to a comments that Mr. Phelps made at lunch and this is how you would characterize the environment and the atmosphere during this period of the TPM, the 701, the 604 and that whole early period. What was it like?

PHELPS:

Well, the, you were talking about the morale was high, we were all fired up and enthusiastic, most of the time enthusiastic. A lot of little differences, there are always are, but. Even Buck and I, maybe I can't speak for him, but I thoroughly respected his judgment even though I didn't always agree with him.

TROPP:

I guess what I'm trying to reproduce is what appears to be a very exciting period for the individuals involved and it's hard to characterize.

BUCHOLZ:

I would think so, but I don't know that we would have characterized it as being peculiar to IBM just computers (?) field in those days.

TROPP:

That's right. The whole period of - did you have a real sense of breaking new ground, which in retrospect, you realized you were?

PHELPS:

I'm not really sure we did. I think that, yes when something worked the first time we were very pleased and we would all stand around and you know..... I've got somewhere in my file the first time the TPM ever did those calculations. It was late at night and somebody put it on my desk the next morning, Charlie Bash, I guess. Here's the first computation. We were proud of things like that. I don't think we were going around starry eyed thinking we were (?).

BUCHOLZ:

Well, I don't know. It's hard to recall exactly how that went. I find it hard to judge what I was doing.

PHELPS:

I think to some extent it was the whole idea of a job that we liked to do in an atmosphere that was reasonably very good. I could tell you a story. There were times when we got made at management. That they were stupid, we could see the right way to go, they didn't agree. [LAUGHTER]. Somebody said we were right, and as it turned out we weren't, (?) we were right.

BUCHOLZ:

I think we were, we thought we were doing a pretty good job when things finally worked. They were not always obvious during the days when all the headaches were there, but certainly when the 702 came out we were pretty proud of that in spite of the fact that it was not really a fundamental departure from the things that had been done before. It certainly was an attempt to compete with UNIVAC but we thought we had a considerably

better machine than UNIVAC in many ways. Although it was not inherently faster, I think the UNIVAC was faster, in its basic arithmetic speed.

TROPP:

I guess I'm getting to another question then and that is something you've touched on briefly. To many people they characterize IBM, which until the late '40s did not have an engineering department per se, did not have a research and development department, people that were primarily concerned with this sort of thing, as being a Company that was primarily concerned with taking ideas wherever they got them and improving on them. So not necessarily one that contributed much to new ideas. Well, that changed by 1949 or at least it looks like it changed. Would you like to react to that characterization?

PHELPS:

I don't really think it changed very much. IBM was different in I think a sense that before 1949, as a general time, I'm not sure exactly, it didn't have the kind of unified organization other companies had. We had a research lab over here and a manufacturing lab, just separate entities with a control. IBM had, in the days before, well I came down here in '47. Before that IBM had six or seven senior engineers all of which (expected?) to report directly to Mr. Watson. Now they probably didn't exactly, but he personally directed what they were....

TROPP:

In essence, that's right. A new direction.

PHELPS:

So it was in the sense that each was a little entity all by itself. That's when we didn't have a research lab, but some of those fellows did some pretty good work.

TROPP:

You only have to look at some of their patents to realize that. Still their work was under direction. They were told here's an area you ought to be looking at.

PHELPS:

Well now, be very careful because I'm inclined to believe that now, I wasn't always. I can tell you some comments on my first reaction to some IBM meetings but I really believe the old man had more than a lot of people give him credit for. One thing he believed in was that he wasn't always right. Every senior engineer had ten thousand dollars that he could spend on anything he damn well pleased no matter what. That was a lot of money, that was not what he made in a year. I mean a senior engineer, at least in the early days.

Nobody could tell him what to do, Watson didn't try. Because Watson felt that if you Mr. Buchholz, or Doctor Buchholz or Mr. Phelps or anybody else, got to that position in IBM, you ought to have some money to do what you want to do regardless of what I or anybody else tells you, and he stuck to it.

One classic case is one with a nice little engineer up in our lab that was doing some work on trying to record on a typewriter, notes as they were played on a piano. Went out and bought a baby grand piano. Now a lot of management thought that was silly and it was silly to buy a baby grand piano, you could use a little studio spinet, but he bought it out of his Watson fund and that was it, that was what he wanted and that's what he got. [LAUGHTER].

BUCHOLZ:

I think that there's always been a problem between a Company like IBM and the other people who were working on computers in those days, most of whom were in the university environment and as soon as they got an idea they published it. When they were building a machine the talked about that and by the time it was running, or maybe more often not running yet, everybody assumed it already existed. Whereas we were restricted to the policy of not talking about anything until after it was announced and by then it was pretty much old hat, in many ways. This has been one of the problems that we really weren't too well motivated until at least the research organization came along to publish and to publish early to get credit for ideas in early stage.

The other thing which maybe is related was because of this element of trying to keep thing confidential, people didn't and probably still don't, do much reading. They don't really absorb enough of what other people are doing to influence their own work and this partly means reinventing the wheel. Sometimes it generates new ideas. I don't think often enough so there really was not enough communication with the rest of the community. I've always been convinced. But part of that problem is just related to the fact that we don't like to talk about things under development unless it's considered pure research.

TROPP:

There's one area in that that I would like to raise and that's that [?] knowing Von Neumann was a consultant during this period. What contacts did you have with him during the TPM, the 701, 702?

PHELPS:

Well, be very careful. I can pick out the document. He became a consultant, I think, in September 1951. He was not a consultant in the early, formative days.

TROPP:

That's right. Because Cuthbert Hurd was the one who hired him so it would have to have been '49 and '50, '51 sounds more like it.

BUCHOLZ:

He specifically consulted on the 701 project and I recall being in on one or two meetings with them and many other people of course. Mainly there to help explain what we were planning to do. But I don't recall what else he consulted on later. He might have been briefly involved with somewhere in the Stretch project. I don't know where, I don't recall.

TROPP:

Well, let's talk about Von Neumann and the 701 then. What, did you feel that he made any major contributions or played any particular role in that development project?

BUCHOLZ:

I don't really have a good enough feel that any more. I'm sure he gave a lot of good advice, especially in the application area. What could and could not be done. What was realistic and maybe they even got occasionally off into the research problems and physics and so on but I don't recall that he ever really influenced much the basic architecture.

PHELPS:

I think the basic architecture and the fact that we were building a scientific computer and his general thesis of a parallel binary computer was well known and he followed that pretty well. I got quite a bit out of his stuff.

BUCHOLZ:

We certainly, as I said before, we were thoroughly aware of the Institute of Advanced Studies machine and to whatever extent he deserves credit for that machine, yes, but not as far as interacting directly in these conferences and in conversations he might have had elsewhere with people from IBM, I have a hard time defining this. This doesn't mean he didn't make specific contributions but I can't recall.

TROPP:

Do you know of any reports he might have written that might still be in existence?

PHELPS:

I don't think he ever wrote any. Very few. There's probably some correspondence somewhere but....

BUCHOLZ:

There may have been reports people wrote on the meetings.

PHELPS:

I think that's a question you could ask Rochester. Haddad would be a good man, but Haddad is not going to be available for a while, so Rochester could tell you that. My recollection--this may not be fair--is that he came in late. The 701 organization was pretty well established when he came in. I'm sure he was shown it but he must have had some comments about it and I'm sure he, something changed as a result of that, but I don't feel that he was a major influence but you might better ask Nat that.

TROPP:

Another question, in terms of the influence on the 701, is the Whirlwind Project. Can you define any areas that that might have had impact?

BUCHOLZ:

Well, the--well, the Whirlwind, of course, already existed more or less, and Nat Rochester being an MIT graduate and--I don't know whether he worked on the Whirlwind Project in the early days--but he--I think he was at Sylvania where they contributed some of the components of Whirlwind.

TROPP:

I think he was knowledgeable.

BUCHOLZ:

He was thoroughly familiar with it. I myself spent a, six weeks at MIT in 1952 I think it was, but that was already after the 701 was announced and I took a bit of time telling them about the 701. I don't know how much, where the direct influence is, I'm sure there must have been some direct connection, but I can't think of them right now.

TROPP:

Well, it's interesting. You know we've talked about this East-West kind of a conflict and the 701 was definitely a West Coast inspired machine, in terms of where most of them ended up.

PHELPS:

Yes, and the CPC leadership.

TROPP:

Right, and yet the architectural influence is clearly East Coast, in terms of the location of the Von Neumann Project.

BUCHOLZ:

I don't think the customers were close enough that they told us how to design the machine. I think they were basically asking us what can you do for us and when we finally told them, and some of them we may have been able to tell, under confidential cover, what we were planning to do. I'm sure there was--that would have had some influence, but I don't think they told us how to design the machine.

As a matter of fact, if you talk about the people from Northrop, people like Woodbury and Murray Lesser, who is here now, who grew up in that atmosphere, they thoroughly disapproved of the 701 type of approach. They didn't think that was the way to build computers. In a way we were doing the opposite of what they would have recommended.

PHELPS:

At one point, Rex Rice and Nat Rochester were so opposite in opinion we couldn't even get them together to talk about it. I don't think it was bitter, I think it was just, they just didn't want to waste their time the other one was so far off base that it wasn't worth their—

TROPP:

Of course, Rex still feels he was right.

ALL:

[Chuckle]

TROPP:

That that particular route was the wrong way to go.

PHELPS:

I think, seriously, that it's hard for a person to tell at this point in time. Certainly Von Neumann had some, Whirlwind had some, the English machines that we knew about. We obviously, I think we literally, as everybody else did at the time, I'm sure that Eckert, Mauchly and the other people took whatever they knew about it.

We took what we knew and tried to merge the best and probably, I'm inclined to think that--I'm negative, I'll tell you very frankly, I'm negative because if you listen to Herman Goldstine Von Neumann knows everything. I'm sure he wasn't everything and I kind of tend to learn the other way which is probably unfair.

So you might better ask Nat Rochester that or somebody else.

BUCHOLZ:

I really consider Nat the guiding light on the architecture of the machine, to use today's terminology. Maybe that's because I worked for him in those days.

TROPP:

It's a name that keeps surfacing, so—

BUCHOLZ:

He and Jerry Haddad were the leaders of the project. Jerry on the hardware side and Nat on the planning side.

PHELPS:

Very good. I think Jerry was technically senior but I'm not sure what the line was and I don't know that it matters.

BUCHOLZ:

Well, they were co-equals as far as I knew it, maybe—

TROPP:

In terms of the people I've talked to those are the names that keep coming up from everybody.

PHELPS:

Absolutely.

BUCHOLZ:

Now one particular, Nat got very quickly interested in programming aspects of the thing and he came up with the idea of a symbolic assembly program at one point. Although apparently it turns out, in retrospect, it was an independent invention of the people in Cambridge. They apparently thought of it at about the same time. That's Cambridge,

England on the EDSAC, but we were beginning to get the feeling that punching holes in the cards corresponding to each bit was not quite the right way to go about this.

TROPP:

How did thinking develop that eventually evolved into John Backus' project on FORTRAN. That maybe again, an unfair question. I talked to John a little bit and I guess I was interested in getting some other view points.

PHELPS:

My only reaction is, wasn't he effectively a user? He just simply...

BUCHOLZ:

He did some, he was, I believe, responsible for some of the software written for the 701. The speed coding, the led him to think further what ought to be done and then the FORTRAN Project got underway and I guess people were skeptical for a while, especially since it dragged on and took a lot longer than they had thought it would. I'm sure it was a break through.

PHELPS:

You would have to ask him. We don't have much to do with that. But that, back on the design of the 701, I think really a lot of that credit has to go to people like Cuthbert Hurd who contacted the field. I think a lot of the design was really based on our understanding of the customer's problem and trying to develop a machine that would--We did it all the time, in fact, we did and do, even though we talked about an [?]. We do on occasion, on a contract basis, release a model machine to a few for use, where the customer takes an experimental machine and actually plays with it. Although we have invited a couple of customers who we have signed a contract with and secrecy and discuss their problems and try to design a machine to fit.

Now I don't know how it was done on the 701, and again Nat may know. I would guess that we contacted quite a few customers and tried to explore their problems and tried to design the machine to fit those problems.

TROPP:

I think the customers recognized that but they also recognized that the difficulty of doing that in that every customer has a different set of problems and a different set of needs and it's impossible to do it for everybody.

PHELPS:

If you talk to one customer, he says, well, they really didn't because I wanted this, and this, and this, and this and he forgot that we did do that and that and that for him.

TROPP:

Yes, but that's what eventually happened. I've talked to many of the people who were there, at the original installation and that's the general reaction. Yes, they were talked to, yes, they felt it was going to be a machine designed for their needs and no, it didn't really turn out to take care of all of them.

BUCHOLZ:

By the way, it's just occurred to me. Have you thought of talking to some of the people on the manufacturing end of the 701?

TROPP:

Up until now, I haven't, but I'm just beginning to get into this and who would be some of the people that you would suggest?

BUCHOLZ:

One person who comes to mind is Ray Voedecker.

TROPP:

How do you spell that?

BUCHOLZ:

V-O-E-D-E-C-K-E-R.

PHELPS:

He's now of the Vice Presidents of Manufacturing Incorporated, isn't he?

BUCHOLZ:

No, I think he's in SPD isn't he? Systems Products Division?

PHELPS:

I don't know, I can look it up in the Corporate Guide and find out.

BUCHOLZ:

He lives in Poughkeepsie, but he's got a job in Harrison heading up an Electronic Manufacturing operation. I'm wondering who else. I'm trying to think. You know we had the 701 reunion in March or April, it was. A lot of these people were there.

TROPP:

I hope I'll get to see that film one of these days. Bobby has seen it out on the West Coast, but I haven't seen it yet.

BUCHOLZ:

What film was that?

TROPP:

The 701.

PHELPS:

We could probably arrange that....

BUCHOLZ:

Oh, you mean the interviews with various people, yes.

PHELPS:

That's, I'd say, mostly personalities, but I can look into that.

TROPP:

But that's still a very important aspect of it.

BUCHOLZ:

Maybe you can get some of the things that were cut out from the thing. [LAUGHTER].

TROPP:

Yes. The historical archives you are not as interested in the finished product that you would if you were going to produce a film for general consumption. The historical document is really much different in that the more raw data you have the happier you are.

BUCHOLZ:

Well, Jerry Haddad dug out the film that was originally made at the announcement time.

PHELPS:

That's pretty good, too. That's quite interesting.

BUCHOLZ:

What was it called ? "Towards the Unknown," or something like that?

TROPP:

I've heard of it, but I haven't seen it.

BUCHOLZ:

Which was, well, a little bit corny, but still not too bad by today's standards.

PHELPS:

They say that's corny, but it could be a lot more corny I think.

TROPP:

Well, that's the kind of thing that I would like to have a print of in our archives. When the Company feels it's interested in contributing that sort of thing. At the moment I would gather it's still Company property with no policy towards what, what eventually will be done with it.

PHELPS:

"Towards the Unknown," I think, really got effectively lost, but cut off for some reason for a class or something. Carl Christenson dug out a copy or found one somewhere, I believe. We go through periods, like everybody else, of throwing away stuff. The only reason I have all these files is that even the old timers, we have had patent problems and today I think by and large we cross-license with almost everybody that we need to. Bell Labs and CDC these and other people. But there was a time when we didn't, and patents could be very critical. You could get a machine out in the field and then find you had a patent that belonged to somebody else and I got involved in a lot of those and I found the records were very important. So I sort of hung on to what I had in the last ten years. I didn't always, but—

BUCHOLZ:

By the way, are you familiar with the TPM patent?

TROPP:

No. I was going to see if I could get the numbers on some of these products. We don't have to put that on tape. I can copy that down later. And any other patents that you have, Mr. Phelps, that you think I ought to have in my archives, I wanted the numbers on.

BUCHOLZ:

That was one of the horrendous patents. I haven't seen many patents in my life. I wonder if it hasn't set some kind of a record.

TROPP:

I've got some candidates for you. [LAUGHTER]. Wow! It looks like a 300 page document.

PHELPS:

Well, do you really want to know? Let's see what it says. Well, it's about 564 columns. That's about half of that, 232 pages.

TROPP:

I wasn't too far wrong on the estimate.

BUCHOLZ:

Well, that doesn't count the figures, so, there's 300 pages.

TROPP:

That's an incredible—

BUCHOLZ:

But I had the original multilith copy that went into the Patent Department and it was several feet deep. [LAUGHTER]. Two feet, I guess.

TROPP:

Electro Data Processing Machine, dated March 22nd, 1954.

BUCHOLZ:

And it was in the Patent Department for the longest time. When was it issued?

TROPP:

Well, let's see, this says '66.

BUCHOLZ:

1966.

TROPP:

That's right, 1966. That's twelve years. You started work on the TPM in 1949.

BUCHOLZ:

Yes.

TROPP:

So, it was five years from that beginning to this conclusion. I'm beginning to run out of tape so maybe I should turn this off.