Track #2.
#1.

S. This is Track #2 of Interview TC-55.

G. Well a disadvantage at that time of course was that the printing mechanism printed the information on photographic film at these high speeds and the film had to be developed. Of course this is not always the most elegant way to have a printed output even more so during those years. It was considered very essential that a printer should be able to print several copies at the same time. Still today this is a very valid objective for a printer. Anyway, this secondary fallout of the ..... light beam deflection was a final result which came out of this work. As far as I know at least, I think IBM has an outstanding portfolio of patents in this field, thanks to this work, in particular the work which the group later on did in Poughkeepsie in advanced technology.

S. That was the group the Germans sent to America?

Yes. The German group was augmented by one of your American engineers and they came up with a joint effort.

S. Who were the ............

G. I should give at least three names. There was Dr. Coulter, a physicist, who was the group leader and Dr. Max and Mr. Kasanka. These were the three people of the group, and each of them had a decent share of original contributions in this field of electro-optics.

S. Are they still here at the laboratory?

G. They are now with Manufacturing Research in Eigen (?), Germany again involved in electro-optics. This time mainly for art work generation for printed circuits. This light beam deflection and related techniques are of course very useful today.

S. I wanted to ask you what you knew about the story of the 3000.

G. Oh I'm supposed to know a lot on this as I was in charge of the program for quite some time. I think there are rather complete records on this entire enterprise of the company available, which have been documented before. The early objective of this was to have a very low cost entry into the punched card market and rather than referring to the later phases of this program, which are very well documented already, I would perhaps take a few minutes in order to go back to the very early history, which is not nearly as well known.

S. That's what I'd like to do to get those things that don't appear in the documents.

G. Right.

S. In case you have anything that is not in the record.

G. I recall it must have been in 1953 or '54, that T. J. Watson, Jr.,,,,(that's Si came here to the German organization and was visiting the Mechanical Design

Department headed by Walter Shar. On one of his visits, he was here actually two or three times, on one of his visits he asked and got the impression, it was not the first time that he was thinking of this idea, he asked Walter Shar to undertake the design of a new system of punched cards which were for the very small user, using a small card, number one with the basic idea that a small card inherently would have to use smaller equipment and smaller equipment must be less expensive because of less material. It turned out that this assumption was a questionable one later on because the smaller you get, there's a point where the technology becomes more difficult again because it is a cut below the optimum size a human being can handle. Anyway the idea was to use small equipment also from a psychological point of view. To have a desk-size system with one man being able to operate the entire system, by the way, an objective which kept coming back over the years and today in the very latest approach of the small system, it is there again. I'm talking of the .37 system developed by Larry Wilson these days.

S. What is that?

G. .37 .... I was saying the .37 system is now being developed by Mr. Larry Wilson who is an IBM Fellow in San Jose. T. J. Watson, in the early '50's, also saw an objective for this system that the system could be taken anywhere in the world where so far we were never even able to install regular punched card equipment at one time. Therefore the objective was that no electricity should even be used in the entire system. Everything should be on a mechanical basis. But as we couldn't live without electricity, we were even thinking of having a human operator generating the electricity through a hand-driven generator. That shows our thinking during the early ideas of the system. Finally the objectives of this design approach boiled down to a system which did have electricity of course, but was using small cards, easy to handle in the manual operation, equipment whihh should be small and neat and essentially desk-type equipment. But also at the same time it should have this multi-function approach. And this perhaps is the most valuable outcome of the early design. The system was supposed to have a multi-function structure which allowed the small customer to do everything ... what the larger customer has to do today....with one or two or at most three different mechanical machines. So at one time the accounting machine contained everything, card raeder, card interpreter, printer, .......... printing. At one time the design showed a swinging printing device which could be operated in two different positions, one to print regular printed records and the other one to print documents by swinging the print device around. At one time the multi-function concept became so complex that everything which had to do with cards

..... which had to do with cards or with printing output was a symbol in one single machine which then became so terribly complex that we realized no customer engineer could ever handle it, so this design had to be given up. But I would say jumping over half a dozen of the early design approaches, it finally ended up in a multi-function concept of the accounting machine which had two card hoppers, two read stations, two card stackers, a punch station after the two read stations. There was only one device compared to our present day multi-function card machine....2560 which was missing in the early 3000 and I guess that was the independent card part or the second read station so that we could actually read after punching again. Anyway I should go back to the layout. There was only one function missing when you compared these early multi-function card concepts with the present day multi-function card machine.

S. Was this machine supposed to be multi-purpose in the sense that it could do scientific type problems or was it just commercial?

G. No it was strictly commercial applications. Simply punched card applications which could do all sensing, collating, punching, calculating punching, gang punching, all the conventional functions with the exception of interpreting.

S. Was it basically an attempt to miniaturize existing punched cards equipment or was it an attempt to generate a small computer?

G. No it was the intention to compress the entire punched card function into one machine for a small user. So he uses the one machine in one run for this purpose and another run for another purpose. But it turned out that quite a number of functions could be combined in one run as was done later on in the Model 20 design again. So that actually he had much less runs, card runs than he would have the individual functions on the machine.

S. Did the Model 20 have any relationship to the experience on the 3000?

G. Oh the multi-function card machine strictly originated with the Model 3000 multi-function accounting machine concept although it ..... in design it went back to San Jose and San Jose incorporated all these ideas in their design. So it was not designed here. Although I'm quite sure that the early ideas of the multi-function accounting machine had stimulated the 2560 multi-function card concept.

S. Shall we continue on talking about the 3000?

G. Yes please, go ahead. Together with the 3000 system, a printer was designed part of the time as I said before it was a piece of the accounting machine and finally we realized that we had to separate some of the functions and take the interpreting out so that the accounting machine would only contain only contain the card reader and the printer and the multi-function card parts but not the sorting mechanism any more and not the interpreting function.

S. And this was to make for more efficient servicing?

G. Yes to break the system into useful individual units.

S. The reason behind all this basic approach toward packaging that we always have is so that we can have reasonable servicing, is that correct?

G. The servicing of the multi-function card machine was really a complex matter and a lot of the later effort went right into the question how to service the machine ... how to produce and how to service such a complex mechanical field.

S. Are the same problems that arose in thinking about the 3000 arising with the current push toward mimiaturization of computers and the packaging problem?

G. Well meanwhile we have learned a lot on how to miniaturize and how not to miniaturize. What we really have learned over the years, not only in the 3000 program is about how to miniaturize components or even entire machines is one that the design principles have to be very straight forward. Second, that these design principles have to match the tolerance requirements and performance objectives in a very well laid out way. In those early days it was not at all as clear as it is today what it means to establish precise design specifications along with the design principles. One of the specific objectives goes right back ..... of the 3000 goes right back to the card layout itself. It turned out that the way information was to be punched in the cards, I mean the layout of the holes on the card themselves, was one of the key factors determining the entire tolerance structure of the mechanical design. And things had been settled in very early years. I think it was '57 or '58 already when the 3000 card was defined as a decimal card by the way, and it was defined in a way which was in no way fully explored with respect to mechanical transport principles, to sensing principles which we later on learned and also to the principles of serial reading with electronic devices. Also in comparing the 3000 card with the card which we now are going to use in the 3.7 system the cards don't seem to be much different and yet there is a whole magnitude of differences between the two cards, in the layout itself, in the way the information is punched and the way the information is coded and in the tolerances which the information on the card is allowed to have. Som e of these basics were not known when the 3000 was started and really were the major contributors to the later problems arising in the complexity of the machine.

S. What about the development that we touched upon before, the Model 20 experience.

G. Well before I go into this I should at least conclude the 3000 story with one sentence. After a serious crisis in the design which occurred unfortunately after the announcement of the system, we went into a late redesign of the entire system, in particular the accounting machine and in particular the card part there which went right back to the tolerance questions of the cards......

S. What was the crisis?

G. Well the crisis was that Manufacturing could not fulfill their early shipment commitments due to technical problems.

S. Technical problems in what area?

G. Technical problems in the accounting machine area. Then we went into a major redesign of the system, particularly as I said of the accounting machine, and came up with a second release which turned out to be up to the specifications. But before re-releasing the system to Marketing, another full review of the entire market was done by that time, and in particular for financial reasons and reasons which had to do with the total sales resources.... the company decided not to get the 3000 out on the market again. It is quite interesting to note that after we did have more than 2,000 orders for the 3000 in the books, and had to discontinue the program, we could satisfy a large portion of this entire market with Series 50 Series 21 type equipment and seen from today, actually the Series 21 revenue was or is more than the total forecast of the 3000 ...... in the early days.

S. Model 20.

G. Model 21 which was a Series 50 type replacement for the 3000 System. It has nothing to do with the 360 Model 20.

S. There had been previous efforts at small machines, probably more scientific. John Lentz had done one in the middle '50's. I don't know if you are familiar with that. It came out with a model number but never sold many.

G. There have been a number of efforts, although I'm not aware of all of them. There also have been efforts outside IBM. For instance here in Germany another design bureau came up with a small punched card equipment proposal too but it never made the market place either.

S. (cannot hear your question.)

G. I'm not sure. Maybe it is because of the under-developed marketing side. I'm suspicious that all these companies .... all the effort in the early days did overlook to a great extent that market requirements have to be explored continually during the entire design and release phase of a product, in order to really hit the market after releasing to the customer. Another thing should be mentioned which goes back to the early 3000 studies and this has to do with the marketing. In this system for the first time we undertook to come up with so-called package applications which are nothing but standard programs for users, where let's say ..... let's say applications for payroll or stock control or retail sales, maybe very similar for a great number of customers. We tried to come up with package applications, standardized applications where the programs as we would say today in those days were plugboards, pre-wired plugboards. These pre-wired plugboards were readily delivered to the customer and he could use it as a so-called standard application. These standard applications keep coming up in the very late and very recent alos new design approach again and again and so far we have not yet really been in a position to develop these standard applications to our full satisfaction. But still the desire is there.

S. Also there is the model that the Office Products Division ...... the 632.......

G. The 632 is an operator-oriented keyboard entry machine and it comes close to the same market, although the idea of the 3000 was to really have the customer organized in a way which is conventional in the punched card business and in the batch processing type of operation and the idea of course was to have this customer ...... in our regular product line. Now coming back to the question of the Model 20 development in the German lab, this again is a rather lengthy story. It started out in parallel to the 3000 development and goes back to the early efforts on the WWAM design. After the German lab on the electronic side phased out of the WWAM, it went to a number of gyrations as I said before, in magnetic logic and logical design of CPU's. We started out with another hybrid design for semi-electronic electro-mechanical accounting machines, went to a delay line CPU approach and finally came up with several core sort of approaches and here I should mention a very stimulating competition in the beginning and cooperation in the later phases between the San Jose laboratory and the German laboratory, both aimed at the same commercial market for small systems and both laboratories trying to really develop something that could be a follow on system for the 1401. As I already mentioned, the German lab started with an electro-mechanical approach, the San Jose lab suggested the delay line approach which the German lab then picked up and carried through to a certain engineering level. Then the next step again came from San Jose where they tried to do an improved job on .... based on a ferrite core memory and finally I think it was in ''63, finally in April, 1963, Mr. T. J. Watson, Jr. visited the German lab and reviewed the entire development situation of the small commercial systems area and decided to pull the entire design strength of the company, namely the San Jose lab and the German lab together in the German lab and design the follow-on machine for the 1401 which later was named Model 20 to the System/360. Even during those days, we were not quite sure yet whether the system should be 1400 competitive or should go a new way and so the system was designed in 1963 using read only memories in such a way that even at a very late date we still could change the principal orientation of the structure of the machine which mainly means the instruction set and the format, either to go 1401 compatible or to go 360 compatible. It was only in early '64 that we finally decided to make the System/360 compatible and the final design took place during this year and we were able to announce the system in 1964, in November, 1964.

S. What were the technical reasons for making it go 360 compatible. Let me explain that question. I don't know too much about it but I've always heard that the Model 20 really isn't compatible with the whole 360 line, so it's a kind of transitional model. Is that right?

G. Yes that's right. The compatibility of the Model 20 of course in a strict sense is limited. What it really does have is the common instruction sets. The Model 20 instruction set is essentially a sub-set of the 360 with a very few specializations.

S. Is this the way in which it is compatible with the 360.........

G. Yes and that is one of the most important things about it, the data format which is compatible with the ........... But on the other hand, the Model 20 has a unique I/O configuration. In particular it does have the multi-function card machine which makes it unique in the 360 line. None of the other 360 members have the inherent capability of handling the multi-function card machine as an I/O device. It needs a special adaptor or simulator to do this.

S. This then provides the link between the Model 20 and the 1401 and the WWAM...........

G. Yes. The multi-function card machine is a machine which is specifically oriented toward the punched card small systems batch processing applications and it is optimum for this purpose. Larger 360 systems ..... different purposes. But still the Model 20 I/O of course is a very valuable set of I/O gear for any computer system. That's why the adaptation of the multi-function card machine to I/O models of the 360 line had to be emulated later on anyway, at least on the Model 30.

G. Well the WWAM didn't have that multi-function card machine concept at all. The 1401 did have a little of it in the 1402 card reader punch which did have some merging capability, but not as far as the 3000 went or the 2560 multi-function card machine went later on.

S. Maybe you want to tell me a little about the multi-function card, where it was developed and why it was developed.

G. Well the multi-function card machine concept .... it's not a card, it's a machine concept, it is to combine as many punched card operations as possible into one machine -- card reading, card collating, card punching, tabulating punching which means reading a card, tabulating the information and punching the results in the same card, gang punching which means punching the contents of one card into another card, collating I did mention all this, all these functions in previous punched card installations had to be done on different machines, each time taking the deck of cards out, carrying it over to the other machine and doing the next step there. And as I described before, ... the multi-function card concept for the first time had been applied in the 3000 in an extended way. It was designed in San Jose into the multi-function card machine. I must mention that the entire I/O for the Model 20 was developed in domestic, the multi-function card machine in San Jose and the printer which essentially was the 2203 printer, was developed in San Jose and Endicott. The German lab made one major contribution I may say, delivering the entire hammer unit .... but aside from this hammer unit, the entire I/O is domestic equipment.

S. How would you characterize the relationship between the 3000 concept and the multi-function card? Is it directly related?

G. If youcompare them today you really see that the 3000 concept is the predecessor of the multi-function card machine except Larry Wilson in designing this, again Larry Wilson, in designing this multi-function card machine went one step further than the 3000 went.

S. What was that step?

G. In having two independent card paths and more selective card stations.

S. Why did these things tend to go to the States?

G. Well because there was a substantial mechanical design effort ....... in the San Jose Product Development Laboratory and the mechanical area of the German lab mainly wasn't strong enough to pick up all this design and wasn't intended to do it either by the way. On the other hand, the German lab was heavily loaded with the total responsibility for the processor and for the system itself.

S. I discussed this with people in the French lab and several of them mentioned to me that the European labs in general were not set up to do these extended jobs and the resources were usually .......... to carry projects through all the ins and outs of the problem............. they went back to the States where the resources, the major ones of the company, they were able to be carried out. Is this the way you view it?

G. Yes that's right. The European labs, although they had different origins, at least the French and the German and the British before 1958, in '58 for the first time the Director of the World Trade Labs at that time established what we call a mission today and the primary mission of these labs was advanced development in the beginning and they were oriented toward advanced development as I described earlier. That's the reason why we went into so many technological enterprises and sometimes even inventions to explore new physical principles which could be applied for computers and computer I/O's. This advanced development orientation which was maintained until '61 or '62, of course gave the European labs a certain skill mix and a certain structure and I guess it was in '63 that the company, along with the entire trend of that time to rationalize on research and development, undertook to justify the existence of these labs by having them produce products. These

European labs then faced the severe problem of a complete mismatch of their skills for actual product development. They were not built for that. They were not equipped for that and they didn't have the skills in this direction, nothing for engineering control or release or even final product development skills. These all had to be created. On top of this, the company took a very rigid step. Sometimes ;it is possible to be too rigid in order to reach an optimum, namely to turn these labs into product development labs and to have these labs produce output in terms of products which can go directly to the market. In asking this from the labs, it meant that we had to change the skill mixes. In particular this request was made under the restrictions that the head count should essentially not very much grow, which means we couldn't add the type of fellows which we are missing. We rather had to re-orient the available skills. This was not the most optimum way to use the available skills. But anyway during those months, it was a rather common practice in the world to bring around and turn even research and suddenly advanced development type efforts into efforts which were able to show productive results, namely products for the market. Not so much for research, but even research was forced into shorter term results. We had to show shorter term results during that time. The European labs have undergone a strenuous period then to restructure their skill and their manpower and to build up all the missing functions, not only the engineers themselves but also the services which are required today and this is about half of the laboratory today, which has to be in services, technical and other services, in order to relieve or release the product to the market.

S. I just wanted to introduce that question. Have we finished with the Model 20?

G. The Model 20 was first announced in November, '64. Then in '65 we already went one step further and the first announcement was a card system only. Then in '65 and '66 we added tape attachments and disk attachments and so substantially extended the system and to this very day the German lab is still involved in further extending the capability of this system.

S. (cannot hear question.)

G. Although it is basically aimed at the same market, you realize that it reaches much higher today, in particular with the disk system and combines tape and disk systems towards more sophisticated and complex applications going right up to the point where full scale 360 Systems like the 25 now and the 30 and 40 can be used.

S. To what would you attribute this expanding flexibility of a system like the Model 20 whose predecessor, the 1401 and the WWAM were more narrow machines?

G. They certainly did not have that much performance and capability. The speeds were lower. The storage capacities were more limited than they are today and of course the diversified I/O and external storage facilities were not nearly up to the level we have today. Although the 1401 did have disk files connected to it, with the later disk files which you have today it is a different performance.

S. To what reason would you attribute the expanded capabilities of the Model 20?

G. To two facts. One, the applications that are developing toward higher requirements which means on the market side and the other was the technical capability imparted to all disk developments and tape developments .... it was very much suggesting that we expand the capability of the system. Last but not least, we have to remain competitive in terms of cost performance. Also in price performance.

S. And therefore the machine was doing more.

G. The machine has to be able to do more today than it had to do during the 1401 time.

S. You might say then that the Model 20 is more productive than its predecessor.

G. Yes of course. It has a more powerful instruction set. It has higher speeds and more powerful storage capabilities. I think that's the situation.

S. Well now that we've gone through the Model 20, is there anything else that we should discuss or have we covered the basics?

G. I think these two major areas which had been starting in parallel to the system development and the mechanical projects in the German lab here, one is the semi-conductor components development. After the electro-optical adventure which we undertook, in 1960 the German lab was chartered to build up a semi-conductor solid state physics capability in the German laboratory. We did this in the consecutive years under Dr. ............ who was hired in '61. We built a rather competent semi-conductor physics group.... department for the German lab which first went into the exploration of caliumarcenide (?) device and materials technology mainly aimed at high speed transistors. The lab was able to demonstrate the first high speed galium arsenide transistor in IBM. But later on the group had to switch to silicon technology for a number of technical reasons and developed in particular some devices .... some silicon devices .... switching devices which were released and are now in production today such as hammer pliable circuits (?) and indicator pliable circuits (?) as a further extension of a cross point switch...... what they essentially are for for terminal circuit device for the carnation (.?) product. The group itself released this carnation switch and also released the hammer pliable and the indicator pliable circuits devices as I said are now introductions for various products in IBM.

S. What was the carnation?

G. Oh the carnation is this line switching process which is going on in the French lab now. It is not yet released.

S. What was the nature of the switch?

G. The switch is a solid state semi-conductor switch which turns on a conductive part via an electrical signal which is imposed on the device. So it is connected to ....... wires on a solid state physics basis.

S. Is the nature of it then a solid state switch?

G. It's a solid state switch which operates with electronic speeds of course. There were relays which were used in these fields prior to this.

S. I see. There is no comparable solid state switching device?

G. No. In fact the entire communications industry has been looking for a number of years for solid state switching devices and they are working in the same field of course but as far as I know, IBM was one of the first to really push this far enough ahead to come up with a solid state solution.

S. What does this result in, higher speeds?

G. Well it allows us to do telephone line switching which so far has been done with relays in the millisecond range, to do this now with electronic speeds in microseconds.

S. Who worked on that?

G. Oh it is difficult to identify a particular individual. Essentially the entire group. Also it must be said that the idea of such a four terminal semi-conductor device was not new in itself. It was known for a number of years that four layer devices could be used as switches except that the technology was not pushed far enough ahead to fulfill the specific or particular specifications which are very stringent for this particular device.

S. Poor communications then.

G. Poor communications.

S. You said there was one other development that you had done..... the hammer and the indicator.

G. I think I started from the end. The first development was the four layer switch for carnatin..... carnation and the other thing is deveoping this further the hammer plier circuit which is essentially a power switch again which turns the power on in the circuit or off and the indicator ......... a derivative of this circuit.

S. Was there something else?

G. Today this entire group is oriented in a different direction, namely in the development of monolithic memories and they have already demonstrated the first private cells which are very encouraging for high density monolithic memories.

S. What is the principle beyind monolithics?

G. Well I'm not sure that I'm the right man to explain this as this is one of the major IBM technologies which has been under development for some years. A number of competent people in IBM are working in this field....

S. Domestic?

G. Domestic in the Components Division..... is their major field now. The German lab only participates in this effort and pushes it in a particular direction which is aimed at low cost monolithic memories for small systems.

S. And the German lab still points toward basically development applications for the smaller systems.

G. This is the primary and sole mission of the German lab, to maintain a spectrum of skills allowing them fullscale development in small systems. And where you have to develop small systems for a cost-oriented market, which means low cost, if possible at all, you have to have as many functions as you can collected ;under one roof so that they can work together, supplement each other in the optimum way and have very short communication lines. This was established as one of the basic objectives and basic mission orientations of the German lab to maintain this fullscale skill, reaching all the way from components to the other side of smaller systems which I didn't mention so far, namely the programming systems.....systems programming of small systems which has been established in the German lab too since 1963 and today the hundred man operation is doing systems programming for the Model 20 and related fields. They also are involved in compiler design but their mainstream of orientation is pulses, supporting small systems.

S. Do they work together much as the Poughkeepsie programming group works together ........

G. Well frankly I hope they work much closer. Of course they are located very close to each other. Because in the design of small systems, the balance between software and hardware is very important and must be ironed out day after day in the design phase.

S. (cannot hear your comment.)

G. Much more important than in larger systems because in a small system we do not have as much simulation capability as any large system inherently has because of its high speed and its high memory capacity. So the small system has to make sure that the requirement from the I/O can be handled in a combined system set up between the CPU hardware system and the software support.

S. All right.

End of Track #2.