ORAL HISTORY TRANSCRIPT

STANLEY H. COHN
INTERVIEWED BY SUMMER CHICK BERGEN
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BERGEN: This is an oral history interview with Stanley Cohn in Oakville, Ontario, Canada, on October 19, 1998. This oral history is being conducted by Summer Chick Bergen, assisted by Carol Butler, for the Johnson Space Center Oral History Project.

Why don't we begin with you telling us about your educational background.

COHN: All right. I'd just like to say I'm very pleased to be invited to participate in this project. It's nice to bring up old memories.

My education has been mainly in mathematics and physics at the University of Toronto. I received a bachelor's degree in 1948. Then I did some further graduate work in mathematics at Indiana University in Bloomington, and completed course work requirements towards a Ph.D. degree, but I had a number of distractions that prevented me from completing that.

As a matter of fact, it was at that time I was a graduate student at Indiana, that I first became exposed to computers in their primitive, primitive form. That would have been about 1951. I obtained a part-time job as a research mathematician there on an Air Force-sponsored project relating to scattering of light from suspended particles, such as fog. It involved quite complex mathematical functions and calculations to get the intensity of the light scattered. So they had installed a small primitive IBM [International Business Machines] machine, it was called the IBM 602A punch-card calculator. You programmed it by plugging wires into a plug board and each program then consisted of a removable plug board that was inserted into the machine. The data were on punch cards in the traditional IBM fashion, and you could hear it clicking away with electromechanical relays as it did multiplications and divisions in a very small memory of about six or eight words and then punched out the results.

So that was my first experience with what you'd call computer programming. It turned out that plugging in the wires was a hazard, especially if you've been lecturing before, with chalk on your fingers and then had these plug wires rubbing the chalk into your fingers. I developed some bad dermatitis, I recall. It took quite a while to clear up. It makes it something you remember. [Laughter]

Another interesting thing about that location, it was at the statistical laboratory at Indiana University. At that time they were processing data for the Kinsey Report. I don't know if you recall that. It was one of the first reports on sexual behavior. They had all these punch cards with important confidential data that they put through the sorting machines in the same room where I was. Of course, you couldn't learn anything by looking at the punched cards, but it was an interesting side light to that experience.

Well, I guess the next thing of interest is how I happened to join AVRO a few years later. I was teaching applied mathematics at a small engineering college, a private engineering college, just outside of Chicago. We learned that the principal benefactor was about to withdraw his funding for this college, even though it was highly successful and well known in that area.

So I began looking for another job, and a good friend of mine in Toronto, this was 1955, the friend told me that AVRO Aircraft had just acquired a new computer. In fact, it was the first computer installed in industry in Canada. There were very few of them anywhere in the mid-1950s. So they were looking for mathematicians and programmers, possibly with experience. There were very few with experience. And he gave me the name of Jim [James A.] Chamberlin, you'd recognize.

So I got in touch with Jim and was interviewed at the AVRO plant. I was surprised how much advanced mathematics they were doing on the aircraft design work. So I was offered a position, actually as an aerodynamicist at that time. There was no category of computer specialist until a year or so later. So I joined as an aerodynamicist and learned about the new computer. It was called the CADAC computer by Computer Research Corporation. You programmed it essentially in the machine's own language. There was no software that came with the machine. It was quite a challenge to convert the mathematical problems into a form that the computer could handle. That gave me a lot of interesting experience.

I think it was two years later when they had done enough, had enough experience with that smaller computer to justify getting a large-scale computer, the IBM 704 computer, which most aircraft companies, in the U.S. particularly, were installing. We put in the IBM 704 computer, and it was a much more powerful and elaborate machine and it had a little fancier programming system. Instead of using the machine language, you could write in symbolic form instead of numerical form. So it was a little more human-oriented, but still primitive by today's standards.

I recall that was a major event when that computer was installed. By then we had the category of computer specialist, and I was appointed as senior computer specialist. That is not head of the computer group, but sort of second in charge. We gradually built up a complement of twenty or more programmers and operators that were required to run that kind of computer. I still have the photographs of the people who ran that computer. That was sort of the opening ceremony.

In fact, the same computer, same model computer, was in use at Langley Research Center. So that proved to be useful when time came to—as you know, we had to leave AVRO when it closed, closed down with cancellation of the Arrow Project. All of us were naturally looking for other jobs. We heard about this exciting possibility with NASA, again through Jim Chamberlin's contacts.

I didn't know much about NASA myself at that time. I only had heard of it by name, under its former name [NACA, National Advisory Committee for Aeronautics]. I was interested to learn more about it. A delegation came from Langley Field [Virginia] to interview a few dozen of us. So that was an exciting time, everybody sort of thinking about future possibilities. I waited a few days for the results of that interview. Again, Jim Chamberlin contacted everyone who had been successful, and he was very excited about the whole event and helped us to organize immigration proceedings and paperwork into the U.S. It all seemed to be expedited very nicely. I guess the U.S. government was very cooperative on this occasion.

So we all went to the U.S. consulate together to find out what papers and documents were needed. After a few weeks, I suppose it was, we were ready to make a major move down to Virginia. I was looking forward to a new environment, and Virginia sounded quite nice.

A complication at that time was that our youngest daughter had just been born, actually just a few weeks before the cancellation of the Arrow Project. This was in early 1959. So we had four slightly older children, plus a baby, to move with us down to Virginia in two old automobiles. But we managed to do it and eventually find nice accommodation in Newport News, the northern suburbs where a new subdivision was being developed. Quite a number of the new NASA arrivals were living there. In fact, we were pleasantly surprised to discover that our next-door neighbor was Gus [Virgil I.] Grissom the astronaut. So I got to know him very well. Around the corner was Deke [Donald K.] Slayton, and I think Alan [B.] Shepard [Jr.] lived in that same development a few blocks away. Many of the ex-AVRO people also settled there and we used to run carpools from Stonybrook to NASA.

What were my first impressions? Well, it was certainly an exciting place. As I mentioned, I was very impressed with the caliber of people I met at Langley. We had a short orientation period. As I recall, we were given a thick manual that had been prepared by the

Research Center on how to calculate planetary orbits. So it was reliving some old astronomy that I never thought would have practical application.

But my first official duties were to provide computer-related mathematical support and computational support for the Mission Analysis Branch, which was part of the Operations Division under Chris [Christopher C.] Kraft [Jr.]. In practice, this meant calculating a large number of operational trajectories and orbits for all of the upcoming missions and dealing with problems of an uncertainty in the accuracy of the data and where the capsule might land. It was called the dispersion area, because you didn't know exactly where it was going to be, but you could cover a limited area where you expected it.

A related assignment was, I was asked to visit the Huntsville [Alabama] installation where the Redstone rocket was built, to compare their approach to trajectory calculation with the one being used at Langley. We were at that time using the 704 at the Langley Research Center, which fortunately was nearby the Space Task Group offices. We spent a lot of time at that computer installation.

So at Huntsville I had an opportunity to meet Wernher von Braun. He was addressing a small visiting group at that time, and naturally he mentioned that the Redstone was old stuff, that he was interested in the Saturn and it was going to put a whole busload of astronauts into orbit, which was something we couldn't visualize at that stage, since we hadn't put anyone into orbit yet.

One thing I discovered was that there were many different mathematical conventions in use by the different locations and contractors as to what coordinate systems they used, what units of measurement they used, and even what were the measurements. You'd expect perhaps that the dimensions of the Earth should be known, but each installation had a slightly different number that they used for the equatorial radius of the Earth. So when you're comparing calculations from two different installations, you had to take that into account.

Later on, I proposed that we have some more standardized constants, even though there was some uncertainty about them. If everyone used the same constants, it would make it easier to compare calculations. John Mayer [phonetic] was head of the Mission Analysis Branch. He was a strong supporter of that idea.

Well, after Huntsville, in fact, John sent me to San Diego, where the Atlas rocket was built at Convair Astronautics. There again, I discovered differences in the approach to calculation. They showed me a computer program they used by the name of Quad. I asked, "Does that mean quadrature for integrating any differential equation?"

They said, "It might, but we take it to mean 'Quick and Dirty.'" [Laughter] So that was my first exposure to sometimes approximate methods that are often just as good for preliminary calculations.

On that same trip, I explored the possibility of putting in our own small computer at the Mission Analysis Branch. It was a Bendix G15, also an early computer, but it looked like a good one and we had lots of calculations to do and Langley wasn't able to keep up with the smaller kinds of problems for us, such things as the coordinate transformations that I mentioned, to compare, compare the work of different installations.

So we did put in a Bendix computer in the Mission Analysis Branch, and I was responsible for getting that up and running. It seemed to work well. All of the—or the majority of engineers in the branch were keen to make use of the computer themselves, and many of them became skilled programmers just as a sideline to their normal duties as trajectory specialists or other type of specialists. So that worked well. That would have been 1959 or 1960. I have to refresh my memory on some of these dates. It was 1959, the first year that I was with NASA.

Well, the next major event, from a computer point of view, was when the Space Task Group took over the IBM 704 that belonged to the Langley Research Center. The Research Center was getting a later-model computer and that was going to be installed in their other locations on the opposite side of Langley Field, so it was natural for us to take over their old installation. For that there was a slight reorganization in the Space Task Group. A separate Digital Computer Group was established to operate that 704 and set up the problems for it, and I was put in charge of that, but I still kept close ties to the Mission Analysis Branch. It was interesting that the central computer group was set up in a very democratic fashion, you might say. All three of the major divisions of the Space Task Group contributed personnel so that it could serve all of the divisions equally.

I guess the first thing of importance we did that was a little different, was to make use of the FORTRAN programming language, the first of the more advanced programming languages that most engineers eventually learned and became very familiar with. It's essentially a mathematics-oriented language for formula translation, FORTRAN. In fact, after hours we arranged to run courses for any engineers who wanted to take the course and learn about FORTRAN, and quite a few did. So that we had a fairly informal arrangement where engineers from all over the Space Task Group could come and make use of the computer, and those that didn't want to would work through the programming staff of the computer group. That seemed to work out well. We got a lot of important work done with that computer.

Later, in fact, it was used to actually monitor calculations during an actual Mercury mission. We had direct connections with the main Mercury Control Center, which at that time was near Washington, D.C., the Goddard Space Flight Center. So our installation at Langley provided backup to the Goddard computers, and we were able to deal with any unforeseen circumstances that hadn't been planned by having a large number of mission analysis engineers right at the computer installation.

John N. Shoosmith, who was another computer person who came from AVRO to NASA, was the key person who handled real-time type of calculations. It was impressive to see how you could predict when the capsule would come over the horizon, for example, and it actually did come right when you expected it to. So that gave you reassurance that the calculations were pretty good.

Talking about the worldwide tracking network reminds me that I participated in the initial evaluation of that network. There were competitive bids from all major—it seemed as if all major high-tech companies had submitted bids either as contractors or subcontractors. There were huge stacks of proposals to be compared and rated to select the suitable bidder. A number of us were closeted for a couple of weeks to evaluate these proposals. That was quite educational in itself and again showed how much talent was contributing to the project.

I recall it was at that time I met [C.] Frederick Matthews, another ex-AVRO-ite, who later became the chief training officer for the worldwide network, the various remote stations all around the world. He was one of the carpool between our housing development there and Langley. I met some interesting people from the Research Center that time, too, who were also very knowledgeable. So it was quite an educational experience.

Well, that was 1960 when we took over the 704 computer at the Space Task Group. The following year, we were ready for a more powerful computer ourselves, the IBM 7090, which was a fully transistorized computer. The 704 still used the old-fashioned vacuum tubes that generate a lot of heat and wore out regularly and had to be replaced. So the 7090 was a more powerful computer and it was, in fact, equivalent to the computers at the Goddard Space Center. So that gave us another degree of backup and compatibility.

I recall we put in a large plotting device at that time, an XY plotter that the engineers could use to draw the trajectories automatically from the computer results, from the magnetic tape that came from the computer. A couple of the Mission Analysis people became very skilled at preparing plots complete with worldwide maps and the actual trajectories. I was gratified to see how well they took to using the computer, even though they weren't computer specialists.

The next thing of interest, apart from the computers, was how did the work at NASA compare with the work at AVRO. Well, there were a surprising number of similarities, as you can imagine, with the analysis and computer support. But I suppose the big differences were in the nature of the problem that we were dealing with. As I mentioned, we hadn't been dealing with anything relating to astronomy or orbits before. In fact, we had to worry about the Earth rotating and how fast it was rotating, and take that into account in doing the trajectory calculations. The sheer scope of the problems were sometimes a little overwhelming.

We began dealing with the tracking that went all around the world, and we learned that a few of the islands where the tracking stations were going to be set up were not accurately pinpointed. They didn't really know the exact latitude and longitude of some of the smaller islands, so part of the development work in the tracking network was to make sure that those could be pinned down for accuracy, because we had to provide each ground station with information on how to pick up the satellite, when and where to look for it. So you had to know where the island was, to start with. It was interesting. So, certainly an exciting time.

It was very energetic work with enthusiastic people. We had the added excitement of the space race between the U.S. and the USSR. Initially they were a little ahead of us, of course. We knew it was important that we had to not only catch up, but pass them by, and we could see that was possible with the large amount of technology and especially computers that we had available to us. The computer advances in the U.S. in terms of hardware technology were very rapid and were responding to the needs of the aerospace industry.

As I say, we had already gone through three or four different computers just in the short space of that many years that I was with NASA, so I could see the evolution of the hardware and, to some extent, of the software. Although the programming systems always lagged behind the hardware, I knew that the hardware, the actual equipment, computer equipment, could keep up with the demands, because you can redesign new computer circuitry a lot faster, in fact, than you can redesign a spacecraft.

But the problem of the software and programming was always a reliability problem. There were numerous bugs that were present in a computer program when it was developed, and you were never sure if all of those bugs had been removed during the debugging process. So that was something that you always worried about when you were developing computer support for critical missions, as these were.

The reassuring part was the methodical way in which the missions were planned and carried out in a very step-by-step fashion. So it seemed relatively straightforward if you just look from one mission to the next, such as going from an unmanned capsule to one that had a primate in it, a chimpanzee, and then the next step, put a man in it. These were nice gradual steps. So if you didn't try to look too far ahead, it seemed straightforward. So that, as I say, was reassuring, then the step-by-step approach, which was something we always liked to use when working with computers, as well. So it's a nice little combination.

In the reliability area, we had a special project going at the computer center. We were requested to calculate the overall reliability of a specific mission before it was flown, so they would have some idea of the chances of success. That was done in conjunction not only with the Space Task Group, but with the Headquarters NASA Group, the reliability team there, who sort of told us the general ground rules for dealing with this problem.

We worked out some interesting computational procedures to put together the various subsystem reliabilities, the alternate possibilities, for example, controlling the spacecraft either manually or automatically, or a combination of the two. Each of these had its own reliability level and then you had to combine them to see what the overall reliability was, allowing for the possibility that some part might fail, would it cause the entire mission to fail or not. So that was a major project we had. I found it quite stimulating. I recall I had to make a few quick trips to Washington to consult with the reliability specialist there, but it eventually worked out well.

I had another very talented programmer in our group, Tom Woods. He was originally from Boston, as I recall. He developed the detail work for those calculations.

What more should I talk about?

BERGEN: Why don't you tell us about your memories of the Alan Shepard flight.

COHN: Oh, yes. Right. That was sort of the landmark flight, as they say. We had the sequence of unmanned flights, and this would be the first time that a man was going up. We knew that the conditions were right for unmanned and primate aboard. Most of the flights had been successful, but not all of them, so there's always some feeling of concern, but we were very optimistic.

In the same building as our computer was located, there was what was known as the tape playback station where the telemetry tapes were recorded and processed. They were in regular touch with [Cape] Canaveral [Florida] and the events of the launch. So we usually crowded into that laboratory to listen to the flight while it was going on. So that was a very exciting time. Everyone was waiting for the news, and it was very satisfying when it all went perfectly.

But I should say that the flight that sticks in my memory even more than that is the one that followed it, Gus Grissom's flight because of my personal connection with Gus and the fact he did get into a little difficulty when the capsule took on water after it landed and the helicopter overhead was having difficulty retrieving either Gus or the capsule. Eventually they did, after a few tense minutes, they did retrieve Gus. So that was a major event.

We gave a little welcoming home celebration when Gus came back, and he whipped up a few of his special Hawaiian punch drinks to celebrate with, and gave me a couple of autographed photos of himself and the Redstone rocket. So those are something I treasure. It was very sad, indeed, a few years later when there was a tragic fire in which the three astronauts, including Gus, were killed. But that's part of the hazard of pioneering work, I know.

BERGEN: So, between Gus Grissom's flight and John Glenn's flight, you left NASA, correct?

COHN: Yes, that's right. That was very early in 1962. At that time we knew that the Space Task Group—in fact, its name had already been changed to Manned Spacecraft Center, and we knew that we were to move to a new location, which eventually turned out to be Houston. So it was a time when I had to reevaluate my personal priorities and decide if I wanted another major relocation of my family and myself. We had some homesickness for our parents and family in Toronto. I knew that a job was always waiting for me with IBM in Toronto. It was tempting, but a very difficult decision to make. With considerable regret, I did leave, but I certainly maintained a lot of connections.

In fact, I was invited to give a number of talks on my experience after I returned from Langley. That kept things alive for me for several more years. But, as you say, I was already back when John Glenn's flight took place. So I didn't follow it as closely as the earlier ones, but I was still very stimulated by it. I remember referring to it in one of the talks I had to give to the Computer Society in Toronto at that time.

I think those are most of the highlights that I remember.

BERGEN: After Shepard's flight, President [John F.] Kennedy announced that there were plans to go to the moon by the end of the decade. What were your impressions at that time of that goal?

COHN: [Laughter] Well, I thought that was very ambitious, and I hoped he had some inside information that I didn't have to make that. Although it was certainly something to have the support of the U.S. Government at the highest level for the NASA work, but I wasn't sure how realistic that time frame was. As I mentioned earlier, from that complex—you wonder whether even the computer aspects of a particular software could meet it. But obviously it was a challenge and it was rewarding to discover that that challenge was met.

BERGEN: Do you remember where you were when Apollo 11, when Neil [A.] Armstrong and Buzz [Edwin E.] Aldrin [Jr.] landed on the moon?

COHN: No, I don't remember exactly where I was, but I remember watching it closely on television and being very stimulated by the event. It represented a goal of achievement that everyone had been striving for all those years.

BERGEN: If I can go back a little bit to when you were being interviewed for a position at NASA, do you remember who you interviewed with?

COHN: Only vaguely. I suspect it was Chris Kraft and perhaps Max [Maxime A.] Faget. There were, I believe, three or four engineers from NASA. Of course, being nervous at the time, the names didn't stick.

BERGEN: Do you remember what they told you about the job you would do, or about the program at that time?

COHN: Well, just to the extent of the need for the trajectory-type calculation and the computer work, which sounded quite appropriate. I think I might have even taken them on a tour of our computer installation at that time, even though it had been largely closed down. We were just a skeleton staff in the Engineering Department and the Computer Department. But the computer was still operational, because IBM wasn't sure what to do with it. They owned it and we rented it from them. I actually ran a few problems, more or less single-handed, for some of the engineers at that time on the 704 computer.

So I did show the visitors around. We were very proud of it. As I say, it was also the only one of its kind in Canada. Canadian industry was always lagging a little bit behind U.S. industry, probably for financial reasons, as much as anything.

BERGEN: When you got to Virginia and you started working with NASA, were the Canadian engineers accepted, or did you keep together in a group? How was that relationship between [the AVRO] engineers and NASA [engineers]?

COHN: No, I think there was a pretty smooth integration, because even though there were quite a few Canadian and British engineers, they were dispersed into the various branches and sections according to their particular skills. For example, in Mission Analysis it was only John Shoosmith and myself being computer specialists and trajectory specialists of a type. We were the only two who were in that group. Everyone seemed quite glad to have us, because they were short-staffed and things were happening very quickly.

I know even a few weeks after I arrived, we had to work one night at a friend's home, another mathematician who lived in Virginia. I visited his home and we worked on a problem late into the night, because it was needed. The next day there was some visiting delegation coming and John really needed some answers. So we seemed to fit in quite closely.

The other example was evaluating the worldwide tracking network, when a large group of NASA personnel were put into this large room for a couple of weeks to evaluate things. We got to know each other very well and to respect each other's capability.

I think Bill [Howard W.] Tindall [Jr.] was the name of the Langley Research Center specialist that I met there. He was also very well versed in computation in orbit calculation. So that was the part of the proposal that we helped to evaluate. So I thought that that worked quite well.

BERGEN: Do you feel like in doing your work that you were provided with the support that you needed to get done your calculations and your programming?

COHN: Oh, yes, anything that was available was put at our disposal. Early on, we did acquire our own small computer. Even a small computer in those days probably cost about $100,000. So it was felt that we needed that and it became available soon after. So, yes, we were very happy with that arrangement.

BERGEN: Computer technology has just grown exponentially in the last thirty years. Can you give us some kind of comparison of what type of computers you were working with?

COHN: Well, I guess the best analogy is the million-dollar computers, as they cost then, the IBM 704 and the IBM 7090. Those had a power comparable to what you now get in a desktop computer, a personal computer. So it's hard to visualize the tremendous advances that have taken place, particularly not only memory capacity, speed, but finally in programming software. It's finally caught up to where you feel a lot more confident when you're using a computer these days. You don't have to worry about what is going to happen. We were always worried about when the computer might break down or the programs might break down at a critical time. So that was why we used extensive backup, one computer supporting another, so you could switch over if that became necessary. But that, again, added expense.

BERGEN: So did you feel confident going into each mission, you and your colleagues, that what had been done was correct? Did you have that confidence in your computers and in your work at that time?

COHN: Yes, we'd run so many calculations and did so many tests and cross-checks in cooperation with the trajectory specialists, we knew that it was behaving the way it should. As I say, we actually did see the capsule come over the horizon when it was calculated to come over. That's the most tangible type of reassurance that things are working properly. It was very impressive, the way that worked.

BERGEN: How do you feel about NASA's use of computers at that time and how the space program helped advance computer technology?

COHN: There's no question that the space program put big demands on computer research, both for the ground-based computers that I was involved with, but even more so for the spaceborne computers, the computers on the spacecraft. Those had to be miniaturized to a much greater extent, obviously, made very lightweight and very reliable. That was where the big demand on the computer research was put.

There were many, many talented laboratories working on those kind of problems, and it was remarkable how quickly the miniaturization actually did take place in the circuitry. You could see it from month to month, almost, the circuits getting smaller and smaller. At the same time they became more reliable because of the different manufacturing techniques that were used to produce the circuits. So that was very impressive to see.

BERGEN: You stayed involved with computers after you left NASA?

COHN: Yes.

BERGEN: Could you tell us about what you did after leaving NASA?

COHN: Yes. Well, for a few years I was with IBM in Toronto as a scientific applications specialist. Then I moved to the Ottawa office of IBM where the National Research Council of Canada is located. They were putting in a new model computer, the next generation of computer after the ones that we had been working with. I was the technical advisor for putting that equipment in and getting it operational for the National Research Council. So I kept in close touch with computers for those years when I was at IBM.

Then I had a very nice offer from the University of Toronto in 1968 to join the engineering faculty in industrial engineering and specialize in computers and information systems. So all of my previous experience was very helpful in making that transition. I stayed with the University of Toronto for some twenty years. It was a very pleasant time, because it had also been my alma mater. I first became attached to it as a student.

Eventually I decided to take early retirement from the university. The funding for universities, like everybody else, was getting difficult and they needed to reduce their staff.

So I was able to sort of go into a semi-retirement at that time. I guess that was about 1989 or so.

So I've been enjoying—I still keep up with the computer field, but I've been careful not to get bogged down in it, which I often felt happened while I was working with computers. You could get lost and caught up with it to the exclusion of everything else. So I've avoided putting in my own personal computer at home so that I could go into other hobbies, other activities. It's been a nice balance, I think. That's most of what I remember.

BERGEN: Well, it's been wonderful. Are there any other special memories of anything that we didn't get a chance to mention?

COHN: Not that I can think of offhand.

BERGEN: I'm going to see if Carol has any questions for you right now. Do you have any questions, Carol?

BUTLER: Yes, I have a few questions. First off, we've covered a lot of your NASA career and we talked a little bit afterwards, but before you came to NASA you were working with AVRO. I see you've got a couple of models out. Would you tell us some of what you did with those programs beforehand?

COHN: Well, that was an exciting period, as well, working with the AVRO Arrow. It was also a frontier of technology and a lot of critical deadlines. I worked closely with the design engineers on their problems. One that I remember particularly was the design of the landing gear, the main landing gear, for the Arrow. We developed equations to simulate the actual landing process and determine what kinds of stress and loads were going to result from that.

It was interesting again to see that you could simulate much of the aircraft behavior on a computer and save time and money, because you needed fewer wind-tunnel experiments and fewer free-flight model rockets by doing the simulation on a computer. So that was when I first became aware that computers had a very important role to play in engineering. That's certainly been the case as time has gone on. Most of the problems were of that type, simulating some part of the aircraft to help them in the design work.

BUTLER: That was the Arrow Program. Did you also work on, I think this one, the CF-100?

COHN: Yes, that was the older production aircraft, the CF-100. That was already pretty far advanced. It was operational, in regular use by the Canadian Air Force and NATO, so it was just a matter of making improvements to later versions of it. So I didn't have quite as much to do with that. We used to do climb trajectories. In that respect it was closer to the future work I'd do, to see how the aircraft would behave under different conditions.

It was a very successful aircraft. It seems to me about 600 of those were manufactured, compared to only five or six of the Arrow, which were then all, unfortunately, destroyed when the project was canceled. So that's still a dramatic moment in Canadian history. I was interested to see that a nearby art shop last week was featuring photos of the Arrow, signed by the test pilot exactly forty years after it was first revealed to the public. That shows you how long it's persisted as something in Canadian history. That's why you still find the strong attachment among the AVRO people to their work on the Arrow, just as there is attachment to the NASA work.

BUTLER: On the Arrow, what was so unique about that project that does have it persist so long?

COHN: It was extremely advanced for its time, supersonic aircraft. Many of the ideas developed for the Arrow were later incorporated into the Concord supersonic jet, which is still in regular use and looks something like the Arrow, in fact. So that it was far ahead of its time and, naturally, was very expensive to develop and manufacture. That, unfortunately, is probably what partly led to its downfall. The Canadian Government wasn't able to support it alone and wasn't able to get too much international financial support at that time.

As I say, it was an important chapter in Canadian engineering history, and still talked about. There were recent documentaries about it and books, and books still being written about it, trying to explain what happened. There are different versions of what led to the actual destruction of those aircraft.

BUTLER: You talked a little bit about computers and the differences between the computers you worked on and these early programs at NASA and computers of today. When you were first starting working in computers, would you have imagined how much they would change and that you could have one on your desk some day?

COHN: No, it was too much to imagine, because when I was an undergraduate studying mathematics and doing limited amounts of calculations on old-fashioned desktop calculators, keyboard-driven, about the most we could visualize computation was we heard of research efforts during and after the Second World War about computer development, but very few people could visualize what you would use them for in everyday or even engineering work.

I was asked that question at Indiana University when I first got exposed to computers. I happened to be discussing with the head of the Mathematics Department, he said, "But what use, what practical use can they be for mathematicians?" [Laughter] So it was very hard to foresee how things would change and how they would become commonplace.

I used to, in early days, be interested in the number of computers that were available, starting with one or two in Canada, and then to a handful, and for many years you could easily count and identify where all the computers were. So now it's quite remarkable to see how they've taken over.

BUTLER: It seems like the use of computers is just going to continue to grow.

COHN: That's right. That's been the pattern from the beginning. I used that same phrase in 1958 when I was giving a talk about computers. Not only has it continued to grow, but as you say, it grows exponentially, and if you don't sometimes sit back and try to take a proper perspective on it, you can easily be overwhelmed by it.

Of course, the current nightmare that everyone talks about is the year 2000 phenomenon, which I have to confess that our generation was directly responsible for. [Laughter] Because we couldn't afford to use four digits for dates when the computer only had a few hundred or a few thousand locations and every location was important. So a two-digit date was adequate for the foreseeable future. But now it's come back to haunt everyone, unfortunately.

BUTLER: Speaking of that, that incident for the year 2000, and I know this is a little off topic, but being a computer expert, how difficult do you think that situation is and what sort of problems might arise from it?

COHN: Well, people have been studying it and worrying about it for several years now, but not everyone has taken it seriously until the last year or two. It's a very expensive undertaking to, in effect, redo all computer programs that might have anything to do with the date, and most of them seem to. So that people are now devoting enormous resources and hiring specialists just for that purpose. One of my daughters' husband is in the computer field and his job at the moment is exclusively to work on that problem, just for one government department, and he's not sure whether they have it licked yet.

BUTLER: Well, hopefully they will get it licked. Coming from Canada, as you do, and then having moved down to America to work a couple of times, and then coming back, and looking at the space program, what sort of impact did the American space program, or even does the American space program, have on Canada either industrially or scientifically, or just for the people?

COHN: Well, I suppose there has been interaction. A number of engineers that started with AVRO went to NASA and then came back again, like I did. A number of those, in fact, stayed in space-related activities, and that probably helped eventually for the establishment of an equivalent organization in Canada, the Canadian Space Agency, which has been quite active and eventually has been able to contribute Canadian astronauts to the U.S. program.

You probably know that Bruce [A.] Aikenhead, who was with the Space Task Group, was in charge of astronaut training for Canada when he came back. He was a very close friend of mine at Langley and we've kept in touch more or less ever since. He's about the only other person who knows my current address, besides Chris Gaynor. [Laughter]

So there was a lot of good interaction of that type. There have been industrial interaction through the Canada CANADARM remote control mechanism and similar such devices. So there's been healthy interaction and cooperation between the U.S. and Canada in the space area.

BUTLER: You mentioned Bruce [Aikenhead]. Are there other individuals that you worked with while at NASA that maybe you'd like to share some stories about, or some people that had a large influence on you while you were there?

COHN: Owen [E.] Maynard's name comes to mind, of course. He's very well known throughout the space program, though actually I didn't have too much close contact with him there. He worked closely with Jim Chamberlin on the contractor liaison work for the Mercury capsule and the later capsules. So he'd be the one to tell you those stories.

I suppose I was influenced more by the people I met who were at NASA when I arrived, such as John [P.] Mayer, who was the head of the Mission Analysis Branch and helped me to get familiar with the whole orbit computation problem. There were regular meetings, of course, of the senior members of the Operations Division, as it was called, with Chris Kraft. I was impressed with how much attention he and the other people paid to the question of reliability and safety. They did things over and over again to make sure that it was really going to behave the way we predicted.

That partially answers the question you raised earlier, how could we have confidence. They always questioned everything that came up to make sure we knew what we were doing. So that was reassuring to have that kind of interaction.

BUTLER: You've mentioned James Chamberlin several times. Could you tell us about him?

COHN: He was the key figure, certainly, at AVRO, and probably the prime designer of both the aircraft, the CF-100 operational aircraft and the CF-105 Arrow supersonic aircraft. He had a variety of titles at AVRO all at the same time. He was chief aerodynamicist and chief of technical design. He called himself chief technician, which was a sort of a low-key title. But the computer department got its start in the aerodynamics group. As I said, I was first hired as an aerodynamicist and when a separate computer department was formed, it still reported to Jim Chamberlin. He was very enthusiastic about the use of computers. Even though we were on a limited budget, he somehow managed to get us what we needed.

He was the person who arranged the whole transition from AVRO to Langley and expedited the return. As I say, once at Langley, I only saw him occasionally because he was in the Engineering Contracts Branch and most of our internal computer work was either in the Operations Division or the Flight Systems Division.

BUTLER: We talked about some of the manned missions that you worked, Alan Shepard's launch and Gus Grissom's, but then the unmanned missions came beforehand. Some of them were interesting in their own right, especially the first one, MR-1, the launch of the Redstone when the rocket did not lift off, when it settled back onto the pad. Were you involved in that mission?

COHN: Well, only to the extent that we did calculations for each mission. I don't recall the date of it, although there is a chronology there. But I seem to remember one or two occasions when that sort of thing happened, and it was very disheartening and disappointing. You felt a major setback after all the work involved. A lot of effort was put into discovering the cause of this, to avoid it happening again. But it just reminded you of the sensitivity of the whole system to small things that can go wrong. That was always a worry at the back of your mind.

But talking about the early missions, there were the Little Joe ones before the Redstone for short flights. A few of those had chimpanzees aboard, and there are always lots of interesting stories about how the chimpanzees behaved when they came back from a flight. One was that after they checked over the chimp and offered him a banana to make him feel a little better, they wanted him to get back into the capsule for some further checks, and he hit the trainer over the head with the banana. [Laughter] So there are a few stories like that.

I remember the astronauts themselves used to collect some of the cartoons of that type and post them up over the Astronaut Training Office, so they entered into the spirit of it quite well. They were a very great bunch to work with. We had lunch with them quite often. It's amazing to realize that John Glenn is going to go back on a flight after all these years. He was always one of the most dedicated. They were all very dedicated, but perhaps he even more so. So he's the right one to do that, if anyone can do it. But he makes me feel I'm not keeping up with things here, if I'm not going up. I used to use the argument that I was over the height limit. The height limit was five-foot-eleven for the capsule. I'm over that limit. But I don't think the same limit applies now with the larger spacecraft.

BUTLER: Well, you'll just have to put your application in. [Laughter]

COHN: Right. [Laughter]

BUTLER: You are going to follow his launch? I guess it's next week.

COHN: Oh, yes. Yes, that will be something to see, to see how he does react at his stage of things. I'm sure he'll do it.

BUTLER: Well, we're looking forward to seeing it.

When you were younger, when you were growing up, was there anything that you were doing at that point in time that led to your further interest, like working on model airplanes, or did you really enjoy certain studies in school?

COHN: I guess mathematics was an interest of mine and it came fairly easily. I was fortunate to have a teacher in high school mathematics who was willing to spend extra time with me after school and give me problems that were outside the regular role. I learned quite a bit that way. That may have been what led me to take mathematics at the university. But as I say, even as an undergraduate, one could never visualize that there would be a demand for mathematicians through the use of computers. So that was a very pleasant surprise in later years.

BUTLER: That's all the questions that I have.

BERGEN: Before we close, I think you have several papers and photos out. Are there any of those that you would like to tell us about or explain to us.

COHN: There are the ones I mentioned of the 704 computer, which was the one at AVRO and the one at Langley initially. The main thing you see on those are the magnetic tape drives spinning, tape drives, which was sort of the hallmark of what a computer was in those days. All your auxiliary storage was on magnetic tape. Same type of tape that they use in the audio, but on a larger scale.

IBM really just put together a lot of its older punch-card equipment and added a few more circuit boxes. You can see the plug board I mentioned. It was still in use for the card-reader, or I guess that's the card-punching equipment. That was just borrowed from earlier IBM equipment and put together, when punch cards were the main means of getting your program into the computer and your data. So it was a long time until punch cards were phased out. So that was one interesting aspect.

BUTLER: When you refer to the 704 computer, is that everything in that picture is that computer, that one computer?

COHN: Yes. Yes, that's one computer. It fills a small warehouse. They're all connected together by cables under the floor. It's a false floor. The operator is in one position doing the control work. The memory is a separate box. Then there are the half a dozen magnetic tape units. The card-reader, the printer was just an old tabulating machine that IBM attached as the main output device. So you had to have all these pieces working together smoothly to run a program.

BUTLER: How many people did it take to keep it operating and running smoothly?

COHN: You can see in this photo, typically at least two dozen people. There's John Shoosmith in the center, and myself over on the side. These were the programmers, operators, and maintenance staff, the maintenance staff supplied by IBM on a permanent basis. They essentially had to live with the computer to keep it running. It required daily maintenance and changing the vacuum tubes that were used as circuit elements. Well, that's what helped contribute to the expense of running these computers, as well.

You can see the dramatic difference not only in speed and price, but in size, when you go from the warehouse-size computer. This was small. When I visited other aircraft companies, they would have two or three of these computers all together in a huge warehouse. So it was an expensive investment.

BERGEN: Is there anything else you would like to share with us before we close?

COHN: Well, I'd just like to say that it's been a very satisfying experience to be able to reminisce with you. Your questions are very appropriate and stimulating. As I said earlier, I'm glad to have been invited to participate.

BERGEN: We've enjoyed hearing your stories. We really have. They'll be a valuable addition to our oral history collection.

COHN: Thank you.

BERGEN: Thank you very much.

COHN: You're welcome.

[End of interview]