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Interviewee: Les Kilpatrick
Interviewer: Robina Mapstone
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MAPSTONE:

All right. The date is the 17th of May, the first day of Watergate; this is Bobbi Mapstone, and I'm talking with Mr. Les Kilpatrick at Calcomp in Anaheim, and this is an interview for the Smithsonian Computer History Project. I believe you started in the East. Why don't we start off by talking about the work you did at MIT and the people you were involved with, and then coming out West.

KILPATRICK:

I went to Texas Technological College and left there in about 1944, I guess. I spent a couple of years in the Navy, went back and got my degree from Texas Tech, and then went to MIT. I was at MIT for two years, 1946 through 1948, and got a master's degree in electrical engineering. I worked in the Project Meteor laboratories while I was there, basically doing work on the development of digital multiplex telemetry systems, which is the first place that I encountered anything digital in nature. When I graduated from MIT, I decided I wanted to move to California. I had been here in the service and was interviewed for a job by Cy Ramo, who was then with Hughes, and John Moore who was with Autonetics, a division of North American Aviation. I came out here before I took a job and eventually went to work at North American Aviation.

MAPSTONE:

Before we get into North American, who were you doing the telemetry systems work for at MIT?

KILPATRICK:

I believe Professor Radford was the head man of that operation.

MAPSTONE:

Was this government work?

KILPATRICK:

It was basically a government-sponsored project, and they were developing telemetry systems for some military applications I guess, but I don't recall the details. I think that Project Whirlwind, which was a computer project, was a parallel development in a different laboratory.

MAPSTONE:

Were you familiar with Whirlwind?

KILPATRICK:

I knew of it and things like that, but I had no association with it.

MAPSTONE:

For instance, none of the digital techniques that you were working on were going over and being used in Whirl-wind or vice versa?

KILPATRICK:

I don't think they bothered to consult us. [Laughter] They were probably much further along in the digital world than we were in the telemetry business at that stage of the game.

MAPSTONE:

When you came out in 1948, had the East Coast/West Coast differences started to become apparent yet?

KILPATRICK:

I don't think they had at that point in time. Digital computers were very large vacuum tube things, and I don't think anybody on the West Coast had done anything significant at all in the computer world at that stage. I think it was later on when things got going on the West Coast that they had a kind of a divergent view on how to design a computer.

MAPSTONE:

I think we can pick that up later. I'm trying to get a feel of when it came about and maybe some of the reasons why. What was happening at North American at the time you joined?

KILPATRICK:

The section I was with at North American was working on the development of a guidance system for a Navajo missile which was a ground-to-ground-air-breathing missile. This

was shortly after the war, and I think the North American people had commandeered a few German missiles and things of this kind. The big push at Autonetics -- it later became Autonetics, I don't think it was when I first went there -- was to develop guidance equipment for missiles. The kinds of things they were developing were inertial navigation systems. These were systems that would have a gyro-stabilized platform to maintain directional orientation, and mounted on that platform would be some form of instrument that would, in effect, sense acceleration. By taking the accelerations referenced in direction by orientation to the stable platform, you could theoretically do proper computations and as a missile flew you could keep track of where i t was at any point in time. Obviously, if you knew where it was during the course of a flight and where you wanted it to go, you could steer it to go where you wanted it to go. I was involved in developing computing equipment to do that computational job. The only practical computing methods that gave any real eminent promise of working in those kinds of systems at that time were analog computing devices, and the major thrust of the organization was in the development of analog computers. I was set off to one side -- I guess with one other man at the time I got there, and it gradually got larger -- to think about the possibility of developing digital techniques to solve guidance equations involved in inertial navigation. Of course, the chance of doing that with the technology that existed then was pretty slim, because the only extant digital computers were very large things that filled a room and were probably too slow to do the job on top of that. The thought of building a digital computer to do on-board missile navigation was pretty far fetched, and there wasn't a great deal of effort put on it. Just a few people set off to one side to think about it.

MAPSTONE:

Who was the other man with you when you first started?

KILPATRICK:

The other man that was working on this, and had been on it for two weeks when I showed up, I think, was a gentle-man by the name of Gene Seid.

MAPSTONE:

He had seniority?

KILPATRICK:

He had seniority, but I had a master's degree and he didn't, so that balanced it out and he ended up working for me basically.

MAPSTONE:

Did the concept of the type of device that was going to be used for guidance come from North American, or was the idea given to you by the military along with your contract?

KILPATRICK:

I'm not sure of that. Certainly North American had con-tracts to do these things, but exactly where the technology came from that allowed them to think they could do them, I don't know. I wasn't high enough up to even worry about it. I think a lot of the work was being done at MIT and other laboratories at MIT at the same time. I know Dr. Draper at MIT was viewed as a competitor in the inertial navigation system business by the North American people for quite some time. He had a very large staff of people that were involved in inertial navigation, which I had nothing to do with when I was at MIT.

MAPSTONE:

It would appear then that the demands of the contract were very much where the state-of-the-art was at that time.

KILPATRICK:

Yes, and like a lot of government contracts, it was on a cost-plus basis. Maybe it was because I was very low in the hierarchy, but I didn't realize anybody really intended to achieve anything; I guess I thought it was a WPA for engineers. [Laughter] Early on, I was working on the problem of controlling the telescope. One of the problems with a gyro-stabilized platform is that the gyros tend to drift. The directional reference that such a gyro-stabilized platform would provide if it rotated a degree, obviously after you flew 5,000 miles at one degree heading error, you would be pretty far off. They had a method of using a telescope to lock onto stars to stabilize the drift of errors in the gyro-stabilized platform. Since this was going to be a missile system and had to be light, small and com-pact, early in the game they chose to use a single telescope pointed at a particular star. The telescope would track that star for a time, then switch over to a second star and track that star and so on. In other words, if you looked at one star you could obviously rotate about that line of sight, but if you had two telescopes looking at two different stars, then you could tell if the platform drifted. Instead of having two telescopes, which would mean more equipment, they decided to solve that problem by having a single telescope track one star for a minute or so, switch over and track a second star, and then switch back and track the first. Eventually, as the missile traveled, it would get to where those particular stars were no longer visible and then it would pick up two different stars and track them. I was working on developing a control mechanism that would very accurately align a telescope pointed at a particular star, move the telescope as the missile moved to track that star, and then very rapidly change over to the second star and track it. The angular rates of the telescope movement were very slow as compared to having to, say, move the telescope thirty or forty degrees in a short period of time to then track the second star. I was working on a digital servomechanism that would operate, hopefully, from punched paper tape to track one star, switch over to a second star, track it and switch back again. We developed breadboard equipment to do that, and out of that work came a fairly fundamental patent in that area on a digital servo. I think it was one of the earliest patents having to do with what is now fairly common in machine tool control and things of that sort. The same process of moving a telescope very accurately obviously

could be transposed into moving a milling machine or something of that sort.

MAPSTONE:

This was patented in your name?

KILPATRICK:

The patent was issued in the name of E. Seid, et al.* I was the et al, so Mr. Seid had his revenge. It was a fairly basic patent which never really amounted to much because North American wasn't in the business of licensing patents. It was a digital register of flip-flops that would hold a digital number which would be summed to give an analog voltage, which would drive a motor with a shaft encoder that would feed back and count down the register to zero. To make the motor turn to a given point, you would drop a digital number into the register and then it would provide an error voltage that would drive the motor until the feedback counted the number down to zero.

MAPSTONE:

When you are flying a missile and you lock onto a star, presumably one knows the reading of the stars from available information.

KILPATRICK:

It always seemed to me that the system was sort of a ring-around-the-rosie that I was never certain would work, but I guess it does. The theory was that the platform was stable and aligned in the correct way, and as the missile moved the accelerations were sensed and computed to figure out where you were.
[*Patent #2,537,427, January 9, 1951. E. Seid et al, "Digital Servo." Mapstone]

If you knew where you were, then you knew where to point the telescope so that you would see the star that you wanted to see. If the star wasn't right in the center of the cross hairs, then you would assume that the gyro-stabilized platform had drifted and you would feed back a signal to move the platform around until the star was in the middle of the cross hairs. Now it seemed that any place an error could come is where you could get off on the wrong track, but I suppose mathematically it did correct long-term drift in the gyros.

MAPSTONE:

Is the platform mounted in the missile?

KILPATRICK:

Yes. It's a mass of equipment mounted in a bunch of gimbals, that give it freedom of motion in any angular direction.

MAPSTONE:

Right, so wherever the missile is, the platform is on a flat position. **KILPATRICK:** The instruments in the center of the three or four sets of gimbals are controlled by gyros to hold steady, and even though you move the outer gimbal, the inner gimbal will stay where it is. Only forward motion of the missile would be an acceleration that would be sensed, and if you knew the direction it came from in three axes, you could compute them and tell how far you had gone. I guess the simplest example is if you were blindfolded and placed in a car, you would know when the car started, if it turned the corner to the right or to the left you could sense those facts, and if you were very accurate, you could tell how far you had gone and in what direction. Of course doing that blindfolded in a car wouldn't be very accurate e, but if you were a very accurate instrument that could sense accelerations accurately and had a good sense of direction, then you could know where you were blindfolded in a car. So it's the same basic principle.

MAPSTONE:

It sounds like a good line for a super detective. I understand that. Was this method used?

KILPATRICK:

It was certainly used in a number of different prototype systems. Whether it ever got into any volume production or not, I wouldn't know, and wouldn't be sure I should say if I did. I don't think the Navajo was really intended to be a stellar supervised system. There were a number of different contracts being worked on that were inter-changeable to a certain extent as to the funds and the common efforts that people were putting into the technology.

MAPSTONE:

Northrop was working on something similar ...

KILPATRICK:

Northrop Aircraft Company had contracts and they were working in similar areas. As a matter of fact they had a contract for a Snark missile, and I think North American had a parallel development contract for the navigational system. I believe that the earliest work we were doing on the stellar supervised system was a part of that Snark sub-contract or parallel development contract that Northrop also was working on.

MAPSTONE:

Was Navajo an Air Force contract?

KILPATRICK:

Navajo, I believe, was an Air Force missile, and I think Snark was also. All the early work that was done at North American Autonetics in the digital computer area, stemmed from and was supported by the development efforts for various guidance systems for different missiles contracted over the years. The people at Northrop, Floyd Steele, and that crowd -- I'm sure you have interviewed some of those people --were working on parallel contracts, and developed the MADDIDA, the 22-integrater digital differential analyzer, which was really the first practical insight that anybody had as to the possibility of building a digital computer that might be able to fit into a missile. Although that computer was far too large, at least it was desk size instead of room size, which was a great step forward. To my knowledge, the logical design concept employed at Northrop in building the first MADDIDA was really where I saw the divergence between the West Coast and East Coast computer design approach. The West Coast people tended to use logical equations to define the logical interconnections of flip-flops and things of that sort, whereas the East Coast people tended to draw them out as block diagrams. Part of that probably stemmed from the fact that most of the people back East were more apt to be working on parallel arithmetic type machines, which basically don't lend themselves to a logical design approach to the same extent as serial machines. That may be another reason that there was that divergence. The aerospace companies' goal was to develop small portable computers, and serial computers had a greater potential for being small if you were clever enough to structure them in such a way so as to solve the necessary equations in a real time environment, which of course was the problem for a guidance system. The guidance equations are a set of fairly complex differential equations that need to be solved on a continual basis. As new inputs come in from acceleration or something of that sort, you want continuous outputs of where you are. The MADDIDA was an attempt to do this. It was a digital computer particularly adapted to solve differential equations, and it was a rather awkward machine if you wanted to do your income tax, payroll or something of that sort.

MAPSTONE:

By today's standards it is a special purpose?

KILPATRICK:

By today's standards it certainly would be a special purpose computer, and even then it was a special purpose machine because although it could solve any number of different kinds of equations so long as the arithmetic capacity was there, MADDIDA was built on an integration principle, the same mathematical technique used in some of the old analog computers or ball disc integrator machines. It was a digital equivalent of a ball disc integrator. A ball disc integrator is basically a variable gear ratio device, so the more integrators you have the more complex set of differential equations you can solve. And the more space it would take. The principle of MADDIDA, was to magnetically store information around the periphery of the drum where, say, each inch along the periphery would store the information for a particular digital integrator. As the drum rotated, it would pick up the information from one integrator, do an operation on it, write it back on

the drum and then pick up the next one in sequence. So it was a serial machine and fairly efficient for the purpose which was basically differential equations. For example, if you have two integrators, you can hook them up, interconnect them and generate sine and cosine functions. One integrator hooked back into itself will generate an exponential function, and those sines, cosines and exponential functions basically are solutions of particular differential equations. Of course with 50 or 100 integrators you can hook up very complex sets of equations. Two integrators again can be inter-connected in a fashion to multiply two variables together.

MAPSTONE:

So with two integrators you have the basic concept of what you could develop.

KILPATRICK:

Yes. The first MADDIDA, I believe, had 22 integrators and the next one developed by the people at Northrop had 44 and on up.

MAPSTONE:

This one was probably 88 and so on.

KILPATRICK:

I think the first one we built at North American had 93 integrators.

MAPSTONE:

How did you get to 93? That's a strange figure. You were starting to play around with ...

KILPATRICK:

Well, we were playing around with digital servo systems, digital circuits, rotating drum memories and things of this kind, when suddenly the people at Northrop developed this 22-integrator digital differential analyzer that looked to us like a breakthrough in technology as far as hope for being able to use digital techniques. We at North American were very interested in that, and we decided that we obviously ought to buy a machine of that kind. About the time we got organized to do that, Floyd Steele and his people had left Northrop and started a company called Computer Research Corporation. We had a problem because some of the people at North American said, "Let's buy a computer from Northrop, they are a big company and they obviously know how to do it." The other group said, "No, Floyd Steele and crowd are the ones that have the technology, so we'll buy it from them." We solved the problem very nicely under a government cost-plus contract, by buying one from each; we bought a 44-integrator digital differential analyzer from Northrop which turned out to be, I think, what they called the MADDIDA.

MAPSTONE:

It's what they called the MADDIDA-44.

KILPATRICK:

And we bought a similar 50-integrator device that Floyd Steele and crowd at CRC decided to build which, by the way, was the first computer that that company built. We had one of each and although they both worked, neither one of them was too reliable. I think the Northrop one actually worked better than the CRC one, surprisingly enough. Both machines had a few thousand germanium diodes in them, and the diodes had a habit of burning out about as quickly as one could replace them, sometimes a little quicker.

MAPSTONE:

So really germanium diodes made life no easier?

KILPATRICK:

They made life no easier. They had a habit of burning out, shorting out or opening up, and even if they didn't do that they were temperature sensitive to the point where if you didn't keep them cool you were in trouble. Those computers had rotating drum memories, vacuum tubes used for flip-flops and things of that kind, and diodes used for the logical switching functions between the flip-flops.

MAPSTONE:

The heat would have caused you tremendous problems if they had ever flown?

KILPATRICK:

As we went on to design machines seriously intended to go in a missile, the equipment had to be packaged in such a way that you could cool it. It was no insurmountable problem, but certainly vacuum tubes were almost an insurmountable problem for the size and volume that we were constrained to use. The size one could delegate for a computer in these kinds of systems tended to be in the order of 2-5 cubic feet, and that was too much in general. The whole operation to build a digital computer for missile guidance really didn't reach practicality at all until the transistor came along, which got rid of vacuum tubes and the heat associated with them, and allowed greater reliability. However, transistors weren't too good either in the beginning.

MAPSTONE:

There are some interesting early reports by people who said that transistors would never work, and this was not the way to go.

KILPATRICK:

There were a number of very interesting years there. In the beginning all the people that were really working on the guidance systems, analog computer people, looked at those of us who were set aside to work on digital things, and every time any project got into trouble they would say, "Why are those guys sitting off over there with no hope of ever producing anything? They claim they are smart, they get paid good salaries, the least you can do is put them on some real work, namely to help us out on our analog computer work." As time went on, digital computers looked like they might work and gradually they got to the point where they did work, and finally to where people quit contemplating the use of analog computers in most of the complex computations that were involved. Of course, analog computers for a long time, and even today, I suppose, in some areas, are limited in their accuracy, but it is a much easier method for getting a rapid solution.

MAPSTONE:

There must still be areas where analog computers are most suited for certain jobs.

KILPATRICK:

Certainly there are places. In fact, any kind of a servo control system has elements in it that a computer man would say are analog. They can be distributed in function, in a way that a digital computer normally isn't. Digital computers have a central arithmetic unit and everything goes through it, but an analog computer can be diffused and spread in many different locations and functions. You could see a whole bunch of analog equipment and not recognize it as a computer, but in a digital device everything flows into one place and back out again. An analog computer, basically, is a hard-wired device interconnected to solve the particular equation you are solving. A digital computer, the simplest ones we worked on in the beginning, or those currently in use, can be programmed to do any one of many different sets of equations, so long as you don't exceed the capacity or the speed capabilities. With the advent of the two digital differential analyzers that we purchased, we then set forth to design our own. We built a 93-integrator digital differential analyzer using vacuum tubes and germanium diodes for switching, but we went to greater lengths to try to reduce the volume, increase the reliability, and give it enough capacity. Ninety-three integrators were calculated to be sufficient to solve the set of guidance equations because the 44 and 50-integrator machines weren't quite sufficient. Our digital differential analyzer took up 2-3 square feet of floor space and was maybe 5 feet tall, to give you some idea of the size of the box. We went to great pains to cool the vacuum tubes by having them plug in modules that would plug into a central section that was water cooled, and running water through to carry away the heat from the tubes.

MAPSTONE:

The parts of the tube that created the heat were close together.

KILPATRICK:

It was sort of a boiler. You had two plates with holes in them and water circulating through, and the tubes were plugged into these holes which were surrounded by water. One could see that if there was a refrigeration system in a missile, that by circulating liquid coolant you could reduce the heat from the vacuum tubes rather than letting it get out into the system. The machine we designed was obviously far too big and heavy to go into a missile, but was only two or three times too big instead of ten or a hundred times too big. The first computer we built at North American was this 93-integrator differential analyzer. However, we also built a general purpose computer whose justification in life was to compute the position of stars for the star tracking system, and punch up a paper tape that could be used to control the digital servo, that I mentioned earlier, to switch a telescope back and forth from star to star to star.

MAPSTONE:

This would have been a ground computer?

KILPATRICK:

Yes, that would have been a ground-based computer. There weren't too many computers around then, but the justification for building one, other than the fact that we were engineers and thought it would be fun, was the fact that a computer would really be needed at each missile launching site to compute the star tapes. The star tape was different for each target location that you might want to shoot your missile to, and for each time that you might want to launch it, because the earth rotates and screws up the star positions for us. [Laughter] The thought was that at every launching site there would be one of these ground-based, general purpose digital computers to figure out how to punch up the star tape to control the telescope. The digital differential analyzer was intended to go in a missile to do the inertial navigation problem solution, which could have been done with or without a telescope. There were inertial navigation systems being developed, some of which used stellar supervision and some which didn't. The name of that first general purpose computer, I believe, was NAPAC and the name of the first digital analyzer that we built was NADAN, standing maybe for North American Digital Analyzer, or many different things. The NAPAC is North American Programmed Automatic Computer or whatever. That's a good one. We built those two machines and about that time transistors were coming along so we built them all over again using transistors.

MAPSTONE:

Both these machines were really prototypes?

KILPATRICK:

Yes. They were both prototypes, experimental systems. However, they were more than

breadboards because they were well packaged, put together systems and I guess they did work.

MAPSTONE:

Who were some of the people by this time who were involved in these machines?

KILPATRICK:

Myself, of course, Gene Seid, whom I mentioned earlier. Sometime along in there Dick Tanaka joined us. I think he did the logical design on the first digital differential analyzer that we made. We hired a group of people from the University of California at Berkeley who had been working on the computer that they developed there. I can't remember the name of it.

MAPSTONE:

CALDIC.

KILPATRICK:

CALDIC, yes. We went up and made a big raid on the graduating class, and hired about two-thirds of the people that had worked on CALDIC.

MAPSTONE:

This was about when?

KILPATRICK:

I started there in 1948, so it was probably about 1950, 1951, 1952.

MAPSTONE:

At this point it was still pretty unusual to have graduating students who had really had hands-on experience with a computer.

KILPATRICK:

Yes. I think these people we got from Berkeley were probably the first people that we ever really hired that had actually worked on a computer before we hired them. Dick Tanaka, Lee Aiment, Chris Wanlass, are people that come to mind right off hand. Fairly early, Mr. Quade from ERA came along, and as time went on there were many people involved. We built the two vacuum tube machines and then we ahead and developed transistorized versions gave them names similar to the ones that I've mentioned except that we stuck a "T" in: NATPAC and NATDAN, with the "T" standing for transistorized.

We built a 93- integrator digital differential analyzer, and in this instance I do recall it was aimed specifically for use in the Navajo missile system. There were probably two or three different machines developed in sequence, each of them, hopefully, getting progressively a little smaller, a little more reliable, and a little better refined. About the time we had the last version developed, working and ready to run into production with something that really worked, the Navajo contract was cancelled. That was the end of that. The general purpose computer, NATPAC, which was developed to punch up star tapes, fell prey to the same problem when SNARK was cancelled.

MAPSTONE:

SNARK was cancelled too?

KILPATRICK:

Yes, it ended up being cancelled. A big joke in those days was about the Snark infested waters. [Laughter] Then we got a contract with Frankfort Arsenal to build a general purpose, portable machine for Army artillery fire control. The theory there was that if you knew where your cannon was, and where the target was, and how big a shell you've got, and a few other things, you could compute how to aim the gun to hit the target. Call back and say, "Move 200 yards to the left and 100 yards up," and the computer could quickly make these corrections and tell you how to aim the gun to hit the target for sure the next time, hopefully before it disappeared. Obviously, in battlefield conditions with artillery, if a computer is going to do this job, it had to be a fairly small, portable, ruggedized device. We aced out a lot of other people and got a contract from Frankfort Arsenal in Pennsylvania to build a computer for artillery fire control, based on our experience in making small transistorized computers (NATPAC). I guess the first machine was called Jukebox, and that series went on and became the FADAC. Quite a number of FADAC prototype computers were developed and built at North American, and later on when production contracts were let, several hundred of these machines were built both at North American and where Henry Singleton went.* I can't recall the name of the company. It will come to me. The basic design for this general purpose machine which was built originally for star tapes, transistorized *

MAPSTONE: [*Les, can you recall the name of this company?]

to see if we could do it, and then sold to the Army for artillery fire control, was finally diverted into a machine that North American hoped to sell commercially called the RECOMP.

MAPSTONE:

So NATPAC really was the starting line and RECOMP became a commercial machine?

KILPATRICK:

It became a commercial machine and quite a number of them were built and sold commercially around the same time vintage as the IBM 650. In fact, it may be some-what earlier than that.

MAPSTONE:

Was it a drum computer?

KILPATRICK:

Yes. All of these machines were drum, serial computers. During all these years there were really two lines going on: digital differential analyzers were progressing through different versions and contracts; and the general purpose machines progressing through different time phases. I mentioned to you earlier before we started recording that North American had a chart for the general purpose computer line and one for the differential analyzer computer line which showed pictures of the machines and a bar chart of their vintage and what they were. If I can find those I will have vintage and what they were. If I can find those I will have a better memory. Ultimately, we combined those two lines, general purpose and differential analyzer, into a machine ', [?] analyzer capability of 128 integrators. This machine was developed and built for [the Hound Dog,] an air to ground missile that followed after Navajo. I think there were several thousand of those computers actually built.*

*[**MAPSTONE:** What is the name of this one? Is it VERDAN?]

The differential analyzer was very good for solving continuous differential equations, but it was very tedious work to set up the initial conditions for the differential equation in the beginning. The theory was to have a general purpose computer that would compute and set in the initial conditions in the differential analyzer, and then the differential analyzer would solve equations in a continuous mode. However, if you wanted to switch modes to a different objective or different target or something of this sort, then the general purpose computer could be used to run in and automatically reset all the initial conditions. For its size, that combination was a very powerful machine.

[End of Side 1]

[Start Side 2]

MAPSTONE:

Did this DDA-GP fly?

KILPATRICK:

All the transistorized DDAs flew. The early ones didn't fly in any kind of an operations system, but in airplanes used to test the navigational systems and things of this kind. The

version of the NATDAN that was reaching perfection at the time Navajo was canceled. was the computer that was used in the Nautilus* and all the submarines that went under the pole. They took the navigation system that had been developed for the Navajo missile, adapted it to provide I inertial navigation for submarines, and used it to sail under the polar icecaps, which had got quite a bit of news back in those days. Knowing the degree of the reliability of the computer, I was glad I was home and not under one of those ice caps. [Laughter] Those sailors had more guts or less knowledge, one or the other, than I had.

MAPSTONE:

I bet you suffered thought that one.

KILPATRICK:

In that same general line of work and people, the last computer intended for use in the Minute Man, but I left North American before that was completed. I'm sure there have been many variations since that in those areas and I hope its not a secret that I go to jail for, to say that some of these current missiles, I'm sure, have computers of a digital nature.

*[**MAPSTONE:** Les, I'm wondering if Nautilus is correct or whether it should be Polaris, or does it refer to both and all others too?]

MAPSTONE:

If you do, you and I and a few others will be there. Up to the time of the Hound Dog missile, certainly, there was no branching off into totally different concepts.

KILPATRICK:

No. They were serial machines with a rotating drum memory. Fairly early in the game, as far as a memory goes, we departed from using the drum. In fact, I don't think we ever built a complete machine that had a drum memory; we built machines using a disk memory. Our disk was, in a sense, similar to the present disk memories, except that we had a single disk with heads permanently mounted and a flat head plate. We used a flat disk with iron oxide coating on the surface, mounted to a shaft by means of a flexible diaphragm, and this was shoved up in contact with a flat plate that had magnetic heads mounted in it reaching type disk memory. As a matter of fact, I think one of the people from a different area of North American left and went to IBM in San Jose. It was after that they came out with movable head disk memories.

MAPSTONE:

Who was that?

KILPATRICK:

I can't remember his name.* I'm trying to think of that.

MAPSTONE:

Ray Johnson?

KILPATRICK:

No. He worked in the gyro area of North American and they were using air bearings there to get low friction.

MAPSTONE:

This disk and head work is almost a complete reversal of what most people were doing, is that correct?

KILPATRICK:

Most everybody else working on drum memories were building magnetic rotating memories.

MAPSTONE:

And the head floated rather than a fixed head.

KILPATRICK:

The drum memories that people were building in those days were not air fluid at all. They used a round drum and mounted the head as close as possible without touching and hoped for the best. We were working on air floatation between the head and the disk. We were floating the disk rather than the he ad, whereas the IBM version and the current disk models float the head rather than the disk, but the principle of using an air bearing to maintain a very small air gap, and hence to hopefully permit you to achieve higher densities is the same.

*[**MAPSTONE:** Les: Does this name come to you?]

The logical structure of the machines that we were concerned with didn't put any great premium on random access. On the digital differential analyzer, we were continually reading from a number of tracks, operating on that data, writing it back on other tracks -- many of them with short, re-circulating loops with maybe twenty or thirty bits of information -- and we didn't need random access. There was no need to move the head from track to track to track as is done in present business machines. We were solving a particular predetermined problem, and although the machine was programmable as to the

equations, because it was special purpose it got high efficiency for a given amount of equipment than do the current general purpose computers that have complete flexibility. As far as I know, that was the first work done on air floating heads versus disks.

MAPSTONE:

Was this patented?

KILPATRICK:

There was quite a number of patents applied for and some of them issued.* Most of them probably are worthless. When IBM threatens me with paying a royalty on disk memories these days, I wonder whether their patents are valid. [Laugh]
*[Patent 3,122,727, February 25, 1964, "Magnetic Disk Data Storage Device," Quady, Marcum, Wildman.

MAPSTONE:

Do you recall who might have their names on some of the disk patents?

KILPATRICK:

There was a gentleman who worked for me by the name of John Lekas, who I believe was Emmett Quady's predecessor. Emmett was responsible for the memory work at the time he and I were both there, and I believe John Lekas preceded him. John was a very prolific inventor as far as filing patent applications and things of that sort. The only problem is that most of them probably weren't that good, or even if they were, they weren't exploited as time went on.

MAPSTONE:

I think the disk, just the fact that it used a principle that later became <u>the</u> principle even though it was different from the way you used it –

KILPATRICK:

We didn't need the random access capability and it did have to have a high tolerance for vibration. The goal was to make the disk small and light and able to stand several Gs of vibration over a wide spectrum. Of course the present disk files which have much higher density and speeds would fail quickly and disintegrate if you put them on a vibration table and started giving them 3-5 Gs of vibration from zero to 100 cycles.

MAPSTONE:

The disk memory developed at North American was used in the Jukebox, the FADAC and the RECOMP. Is that correct?

KILPATRICK:

Yes. It was used in all the computers developed at North American until after I left there, which was in 1959 or 1960, I guess, and probably for some time beyond that. Certainly today you wouldn't use it because you would build a semi-conductor memory for those applications.

MAPSTONE:

Did you ever get into core technology for memories?

KILPATRICK:

No, we didn't get into core technology because we were dealing with machines of a serial nature, and the switching circuits involved to scan a core memory in sequence used a lot more circuitry and power than the rotations of the drum. The drum rotation did much of the selection because the data was oriented such that we picked up one part, operated on it, wrote it back, and picked up the next part. Aside from the drum being a fairly cheap, small, and hopefully inexpensive device, its rotational selection of data also provided a functional purpose that otherwise we would have had to build in electronically in a static memory like a core memory. .Cores were big and took a lot of power and provided random access speeds much above a drum, but they didn't do much for the logical structure of the kind of machines we were building.

MAPSTONE:

Going back to the entrance of the transistor, can you recall when you started to work with them?

KILPATRICK:

It's hard to recall the exact dates. I started working for North American in 1948 and I would say 1950, 1951 was about the first time that any transistors came out that you could lay your hands on. The transistor clearly made it feasible to hope for shrinking the size and power of these machine down to where they could really be practically used, whereas it was relatively unfeasible with vacuum tubes.

MAPSTONE:

Once you had bought these transistors, did you play games with them to develop your own feelings about their feasibility?

KILPATRICK:

Oh, yes. There was a fair amount of work done there. We bought transistors from anybody that ever made any and tried them out at great length. For a time there were

even a few people sitting off in the back room sticking wires on germanium things trying to make their own, [laughter] which didn't amount to much. To my recollection, the NATDAN computer was clearly the first transistorized airborne computer that was ever built in the world.

MAPSTONE:

Can you put an approximate date on that one?

KILPATRICK:

I would guess 1952 or 1953, sometime in there.* This work was going on more or less in parallel in the same *[Material received from North American indicated that NATPAC work was started late 1952 and continued through I world, showing our degree of marketing expertise.

MAPSTONE:

[Laugh]

KILPATRICK:

A little money was brought forth, and we modified the machine a little bit to turn it into what we hoped was a commercial version. I guess as time went on there were people set up to try to market it, but looking back, the company was organized for military business, and they were not organized, nor did any of the people really have any experience, with the commercial world. The input/output equipment on the machines were sorely lacking; we had many drawbacks. We have very limited input/output equipment and we thought being small meant something when doing the job. Maybe being he was getting more for his money.

MAPSTONE:

[Laugh]

KILPATRICK:

I don't know how many RECOMPs were sold commercially, there must have been fifty or a hundred of them, but this was about the same vintage time as the IBM 650. With the right know-how to get the right kind of bigger memories, peripheral equipment, and marketing and sales and separate environment to concentrate on that, I think it could have been a great success commercially. But it wasn't, and I am sure it was due to my failings as well as everybody else's. We knew so little about the commercial world.

MAPSTONE:

What were the input/output devices?

KILPATRICK:

Well, the RECOMP had a typewriter, a teletype that punched paper tape input and output; a drum memory, a few thousand words of disk memory, and that was sort of it.

MAPSTONE:

No high speed printer?

KILPATRICK:

No high speed printer, no magnetic tape, no card input/ output; none of the things which it should have had in that vintage.

MAPSTONE:

When the computer was sending messages out, printing out, could it do simultaneously internal calculations? In other words, did it hold itself up?

KILPATRICK:

I can't recall that. I think that it probably was capable of printing and doing something else at the same time, but I'm not even sure.

MAPSTONE:

Because that was one of the problems around that period. At this point, you were going into direct competition with IBM?

KILPATRICK:

Those of us that were working on computers had those goals.

MAPSTONE:

Did you at that time feel the significance of IBM and its hold on the market?

KILPATRICK:

I don't think we realized the position that IBM had, although they were certainly very big and the leading company in the commercial computer world even then. At one time, before IBM brought out the 650, they sent big tours of people out to look at the NATPAC, and we had dreams of selling hundreds of them to IBM, which never materialized. I think, in hindsight, that they were probably more interested in making a

judgment on our ability, the capabilities of the computer and what we might do with it, rather than being interested in buying it.

MAPSTONE:

Checking out the competition?

KILPATRICK:

Yes, I would suspect so.

MAPSTONE:

Did you have contact with RAND?

KILPATRICK:

Not in my area particularly, no. We knew some of the people, of course, and we would get together at computer conference meetings and things of that kind. Dr. Willis Ware, who is now at RAND, I hired from Princeton to work on computers at North American. He became disenchanted with gray walls, no windows, and serial machines aimed at missiles instead of large parallel machines, and he departed for RAND, where he built a higher-speed, parallel, Princeton-version machine.*

MAPSTONE: [*Johnniac]

MAPSTONE:

The last project you were involved with was the Hound Dog missile?

KILPATRICK:

Well, the last project that was ever finished was Hound Dog. The last thing I was working on there was the computer for the Minute Man that hadn't been completed at the time I left. It was well along in the design stage, but not yet a working machine.

MAPSTONE:

Let's go back a minute to RECOMP. At the time when you started to sell RECOMP commercially, did North American spin off or separate out a group of people to become the commercial selling division?

KILPATRICK:

They separated out a group of people to do the selling, separate from the rest of the computer organization. Certainly there was no separation out of the whole group of

engineering, and manufacturing and marketing. People were hired to market that machine, but the engineering was still done by the same group that was doing other work for the military, and the production was in the same plant that was doing other things for the military. **MAPSTONE:** What about the hiring of salesmen. Was North American hiring engineering-type people, or was this something that people were unaware of at the time?

KILPATRICK:

I think basically they started off with a few sales-oriented engineers that happened to be around the plant, but they probably hadn't had too much experience in the computer world, which was one of the mistakes. I don't recall them going out and hiring the red-hottest computer salesmen in the commercial world, they probably didn't realize there was a difference.

MAPSTONE:

There probably weren't too many.

KILPATRICK:

That's true. There weren't that many. That was the days of the card calculator devices and things of that sort.

MAPSTONE:

Yes, right. That was still an emerging art, if you will.

KILPATRICK:

I think the poor guy that first had the job of trying to sell the RECOMP was a fellow by the name of Bob Geiger, whom I haven't seen in some years. They went on and eventually ended up with a reasonably-sized staff selling the machine, but I am sure North American wished they had never thought of it. They certainly lost money.

MAPSTONE:

[Laugh] 0n these machines, the FADAC and the RECOMP for instance, did North American do all the prototype work and then contract some other company to build them, or were they in the business of building them too?

KILPATRICK:

We developed and built them and almost none of it was subcontracted.

MAPSTONE:

So you had a production line really?

KILPATRICK:

Oh, yes. Between the Hound Dog and some of the other computers at one point in time, I think North American was probably the second largest computer manufacturer if you counted numbers of computers rather than size or dollar volume and things of that sort. Quite a few thousand computers were ultimately built.

MAPSTONE:

You are saying second to IBM.

KILPATRICK:

Yes, but unfortunately not in dollar volume or profits.

MAPSTONE:

I presume the user people at North American were quite separate from you.

KILPATRICK:

As time went on there were whole groups of people using computers for their data processing and scientific computations, particularly people at the corporate office in Inglewood. Frank Wagner, for example, who's at Informatics, his main statement every time I saw him was, "Why don't you guys go back to bending sheet metal like you ought to and we'll buy our computers from IBM."

MAPSTONE:

[Laughter] That sounds like Frank Wagner.

KILPATRICK:

There was not much communication between the hardware development people and the computer user people in the corporate offices and places like that.

MAPSTONE:

That's fairly significant, because what one starts to see now is that Wagner's group and Jack Strong's group were terribly important users of computers and were pioneers in methodology.

KILPATRICK:

If North American had got us all together and told us to develop something that Wagner and Strong could stomach using, and vice versa, we might have had something going. And, of course, if they had been willing to throw a few million dollars into the tilt, and separate all the people out from the military work and say, "You're in the commercial computer business for real." While I was there it was always my dream that one day they would do that, but it never quite happened.

MAPSTONE:

Something we talked about the last time which I would like to discuss generally, is the contract situation with the government, and the fact that contracts tend to be fixed at a certain price, right?

KILPATRICK:

They weren't in those days. Essentially all the contracts in those days were cost-plus-fixed-fee, and typically they were overrun, which was an abuse in one sense but in another sense provided the capability to do things that would never have been done at fixed price. There were development thin9s that had never been done before, and I think anybody would have been insane to have bid on those things as fixed-price contracts. Many of the people who later on did bid on fixed-price military development contracts, discovered that it's kind of hard to be sure of what you're doing. It's one thing to bid on something that you've got in production a fixed price and know what the costs are, particularly if you have a margin of maybe two or three times its manufacturing cost is the price you're selling it at. However, if you are doing military development work that you have never done before on a fixed price, and if you are guaranteed that renegotiations are going to take all the profit away over a few percent even if you happen to be smart enough to do it, you have nothing to gain on the up side and everything to lose on the down side. I don't think the kind of work we did in the early days at North American would have ever been done on fixed price contracts, because the risk was too large and the reward miniscule, even if you met the contract.

MAPSTONE:

When did the government switch to fixed-price contracts?

KILPATRICK:

To my recollection, they were really beginning to switch from cost-plus to the fixed-price as much as they could about the time that I left in 1959 or 1960. The cost plus business went on for the next few years beyond that to some extent, but I would say that by 1962 or 1963 the government was off the kick of buying everything at fixed price if they humanly could. There was always some sucker willing to bid fixed price at whatever amount of money the government alleged they had, and that's really when a lot of people quit spending their time and efforts on that kind of work. I left North American late in

1959 and started Cal-Comp. The first contracts we had were government cost-plus-fixed-fee development contracts, which went along very nicely for a year or so. About the time the government decided everything ought to be fixed price, we decided that if we were going to take all the risk we might as well have hope for all the reward, and began switching off into commercial projects. This ended up in our being in the plotter business and things of that sort.

MAPSTONE:

Part of this cost-plus-fixed-fee gave people like self a chance to develop your product and then commercially exploit it.

KILPATRICK:

Yes, it did do that. However, most people found that with the kind of techniques and organizational structures that they had for government work, didn't pan out too well when trying to switch a portion of that over into the commercial environment. The number of instances of government development and production work cohabiting with commercial product work, both being successful are rare, if you can find one at all. ERA was a fine example of that. "If only we had been able to pull ourselves together, we'd have had all these ventures that could have been commercial, but we couldn't t do it."

KILPATRICK:

I think if North American, who were in the field as early as anyone, had taken this whole group and set them off in a separate company environment out in the real world dealing with end-user customers, and with enough capital to make the kind of mistakes that were obviously going to be made, short of having no talent at all, we could have done very significant things in the commercial computer world. But that wasn't the environment. From the cost-plus-fixed-fee days, they were in the habit of, "If you give me a contract and guarantee to pay, hopefully, cost plus a percentage basis, then we'll build it for you." The thought of pure risk appropriating a few million dollars on a venture, at least from my level in the company, didn't go over too well at the high levels of North American.

MAPSTONE:

Of course, it was still the early days of the computers, wasn't it?

KILPATRICK:

Yes, and nobody could foresee the potential that the computer world has since realized.

MAPSTONE:

That's right. There were only two major companies -- IBM, who had been in the business so long that they were hardly considered a new entry, and UNIVAC/Remington

Rand. I presume, at that point, that the financiers weren't putting big money into the computer industry.

KILPATRICK:

No. Those weren't the days of people running out and starting companies to go into the computer business. Maybe they ran out and started companies to go into the government defense business, a la Ramo-Wooldridge and people like that. But if I had run out and looked for capital to go into the computer business, I don't think I would have found any.

MAPSTONE:

Tell me about how you got around to starting CalComp.

KILPATRICK:

After ten or eleven years I had risen to a fairly high level at North American. I had a few hundred people working for me and I think the position had gotten to a point, whether true or not, I felt it had a few political as well as technical problems, which I found somewhat discouraging. Eventually myself, Gene Seid, who I had mentioned earlier, and another engineer by the name of Ron Cohen who worked for me, decided that we really ought to think of something else to do. We were inspired this a bit by John Chisholm, a friend of mine from MIT who had gone to work at Bell Aircraft in Buffalo, then had left there and started a small company, Sierra Research Corporation. Chisholm would periodically come into my office at North American, prop his feet on the desk, tell me how great it was in the outside world and, "How do you stand these acres of green walls?"

MAPSTONE & KILPATRICK:

[Laughter]

KILPATRICK:

John Chisholm was an analog computer man basically, and he worked on aircraft landing systems and such things with Bell Aircraft. He had run into a little requirement for some sort of a digital device for the government, or one of the big aircraft companies, or something of that sort, and would give the job to me and my little group who had decided that we ought to see about doing something else. We would work nights and write a proposal for this little thing, give it to John, and he would submit the bid to whoever it was. If he got the contract he would tell us, and then we would stay up nights to engineer the thing, solder it up and ship it to him. When he shipped it to the customer, he would give us our cut. We spend a couple of years working days at North American and nights in a garage, in essence, and we found it was fairly profitable. We had no salaries to pay and we ended up using the shop of another friend of ours, a fellow by the name of Bob Morton, who is still here at CalComp, who had no business in his one-man company and

was lonely. We would go down to his plant wondering what we could ever do to get started, go out and have a martini and forget it. Eventually we got to where we would go down and write a proposal for John Chisholm, get the job and build it in Morton's shop, ship it to Chisholm and get paid. With no rent or any salaries, we didn't count out labor since we were still employed, the only expenses we had were the parts. So it was relatively profitable even compared with cost-plus-fixed-fee of seven percent. We decided that if we could do as well full-time as we were doing part-time, we ought to give it a try. We developed things like an eight position multi-plexer for a telemetry system, digital-analog converting devices, and things that were digital in nature but weren't what you would really call a computer, but the same technology. Finally we decided to give it the old college try, so the three of us all walked in and resigned and hired a gentleman by the name of Gene Beckman, a contract administrative lawyer-type who we had known at North American and who just happened to be leaving the same day. He was going to work at Ramo-Wooldridge, so we grabbed him and asked him to come with us instead. The start of CalComp in its present vein was a four-man partnership, Gene Seid, Ron Cohen, Bob Morton and myself. Gene Beckman was hired at the last minute as we were walking out, so we really had five people; four engineers and a lawyer, and needless to say, we set forth to look for a government contract.

MAPSTONE:

No capital?

KILPATRICK:

Essentially, no capital. We had saved a few bucks, I would say total liquid capital of $10,000 or $20,000, maybe a little more if we robbed the piggybank. A month or two went by and we got a government contract from our friends at Frankfort Arsenal to develop a portion of the FADAC system, a display unit that hadn't yet been developed. Ray Brockman, the contracting technical man at Frankfort Arsenal, was the man we dealt with mainly, and he knew us from FADAC and Jukebox. He thought we were competent and knew our overhead was low, so we got a $100,000 cost-plus-fixed-fee development contract from Frankfort Arsenal which was really our first business. That went along and we got a few more add-ons and overruns -- we hadn't got out of that habit yet. Other than Frankfort Arsenal, the first sizeable contract we got was from NASA which had sprung up in the meantime. We got a contract from them for about $595,000 for cost-plus-fixed-fee development for a timing control device to go on the Nimbus satellite, a weather observation satellite. That gave us considerable more business. Needless to say, whenever we got a little more work, we would pick up the phone and call one of our old buddies at North American and say, "Now." For a number of years we weren't the best of friends with North American. I should say that North American didn't like us, I always had a reasonably soft spot in my heart for them, but for a period that soft spot wasn't reciprocated. Bob Morton s one-man shop was set up originally to build a plotting device to go on a digital differential analyzer. Morton was a college friend of Gene Seid's, they both graduated from USC and both worked at North American -- Gene Seid for me and Bob Morton over in some other area. They had been ham radio fans and

had a garage where they built radio transmitters and things prior to this time. Bendix or Northrop or someone wanted a plotting device to hook onto one of these MADDIDA-type computers, and were interested in having such a device developed. Seid and Morton decided they could build a device of that kind and tried to get a contract to do it. Needless to say the contracting people at Northrop, or whoever it was, laughed uproariously and gave two con-tracts to other people. Seid and Morton went ahead and built a plotter in their garage without a contract or money while they were working at North American and theirs worked and the two that were funded didn't. So with that impetus they both quit North American and started CalComp. Right after that was when Litton came up with their little 22-integrator desk top device which they thought they were going to sell to every engineer, and they thought a plotting device would be great. Not only would every engineer have this little computer, he would have a plotter to plot out his problem solutions. They could see that Morton and Seid weren't too big a production oriented place, so they ordered the plotters fast so they could get them when they needed them. Business went along fairly well for a while and they sold a reasonable number of plotters, but the Litton computer didn't pan out, and nobody needed a digital plotter that we all thought could only work on a digital differential analyzer. DDA has a characteristic that as a variable changes you get a pulse train that you kind of count up and count down. Each little pulse would be pulled out and run a step-motor-type plotter, it would move it one increment, an X and a Y. So it was natural that we thought a plotter of this kind was only usable on a digital differential analyzer.

That business had gone to pot, nobody was buying them, and Seid gave up and came back to work for me again at North American. Morton was still sitting there, a very frugal fellow with no business, but he wasn't married, didn't have any expenses, so he was waiting around. That's why he was happy to have us come down and work nights, he was lonely. At the time the three of us from North American and Bob Morton formed this partnership and started off to look for a government contract, they had this plotter which had gone from a two-man company to a three-man company back down to a one-man company. They had a ratchet and ball-step motor driven plotter, however, we didn’t start the company based on exploiting that because nobody’s ordered one in years and it didn't cross our mind that anyone would. We went into the government contracting business but gradually we began to sell one or two plotters. The people at Bendix had a digital differential analyzer that they had bought from Northrop, and they also ended up with a general purpose computer, and they began to buy a few plotters. Finally it seemed like they were buying more plotters than we could fathom they were building differential analyzers. For a time we were very curious as to why and for what, and it turned out they were hooking them onto general purpose computers, which we had never realized was a possibility. In other words a general purpose computer could compute in whole numbers and still put out incremental trains in everyday fashion. So we began to sell a few plotters to Bendix along with our government development work. At the same time as the plotter business began to go up a little bit, the government began to get very sticky and want their work done on a fixed price at below whatever the latest bid was. Gradually we began to switch over more into the plotter business and less into the government contracting business. We found if we could get an order, we could build a plotter for $1,000- 2,000 and sell it for $3,000-4,000, which was a much higher profit

margin than a government contract, particularly if it was a fixed price development that you had to underbid to get. So we gradually switched over into the product business, and I would say there came a magic day along about 1962, 1963 or 1964, sometime in there, when we really starting putting our best talent on our own products and whoever was left over on whatever government contracts we had. Of course that makes a pretty fast switch, so we began to go up in the commercial product business and dribbled along in the government contracting business. We still do a little bit of government contract business, but very little.

MAPSTONE:

So the name CalComp came from Morton and Seid?

KILPATRICK:

Yes. The third man that they hired in after they had started, was a fellow named Bruce Sawyer who was originally at North American. He has since left and gone to Litton. Bruce Sawyer came into CalComp along with Morton and Seid and worked there for a time, but when the business got poor he went back to Litton, Seid came back to North American and Morton held down the fort. Mr. Sawyer is now one of the principals in Zionetics, of which you may have heard. They make a flat bed plotter and are one of our competitors. Mr. Sawyer likes to point out that he was one of the original guys in the plotter business. I like to point out that when he was in it folded.

MAPSTONE:

[Laughter] I suspect you really know how to hurt a guy.

KILPATRICK:

But he's doing very well now, so I guess I'm not hurting him too much.

[End of Tape 1, Side 2]

[Start Tape 2, Side I]

MAPSTONE:

We were talking about CalComp and I would like some statistics. When actually was it formed as a company?

KILPATRICK:

CalComp, which had some predecessor name that I can't remember now, turned into California Computer Products pretty early. I think the company was formed around 1953, 1954 or maybe 1955, and it went on for a year or so as a one-man venture run by

Bob Morton, who was still there. Seid, Cohen and myself began working in Morton's shop in about 1957 or 1958, and we left North American in late 1959. The company in its present form, starting from one man with basically no business, really started in late 1959, although there was a predecessor in existence some time prior to that.

MAPSTONE:

Is that about when you got your Frankfort Arsenal contract?

KILPATRICK:

Yes. I would say in 1960.

MAPSTONE:

Was it unusual for a military concern to give out a contract to a totally unknown, non-substantial company?

KILPATRICK:

I think it was unusual, bit I don't think it was completely non-existent. Those were the days when they were looking more for people and their talent than they were at the money, and on a cost-plus-fixed-fee contract, you really don't need much capital if you can get your bills paid promptly. The attraction we had to Frankfort Arsenal was that we were very familiar with their system and their problems, they knew us as people and engineers, and our overhead rate, which had grown after we had had the contract for awhile to about 20 percent total, was still very low. The more typical rates were 100-200 percent manufacturing overhead, 100-200 percent engineering overhead, and G&A on top of that, etc. So we were a great bargain for the Arsenal, in that they got the talent of some, I hope, relatively competent engineers at darn little more than their direct salaries. They were hard pressed for money, and looking for a way to get something done at a minimal cost.

MAPSTONE:

It was good economics for them?

KILPATRICK:

Yes. I'm sure that my friend Mr. Brackman at Frankfort Arsenal, who gave us the contract, had a few arguments as to should he or shouldn't he? We didn't have sufficient knowledge of the business world-- I'm not sure if the investors were there in the sense that they have been since then. We didn't know how to go out and try to raise venture capital money to finance us, the thought never hardly occurred to us. In fact, no outside capital came into the company until we went public in, I think, late 1961 or so.

MAPSTONE:

That's incredible.

KILPATRICK:

We financed the business by cost-plus-fixed-fee contracts along with whatever money we put into it initially, and by hiring another engineer from guess where. We would say, "You are making a thousand dollars a month, and we are going to pay you a thousand dollars a month and we are going to let you buy $250 a month worth of stock, which we will take out of your check."

MAPSTONE:

[Laughter]

KILPATRICK:

That was our only means of financing until later in 1961, when we did a publicly underwritten $400,000 grade A, as it was called, financing with our friends at Mitchell, Jones and Templett. Of course, since then we have done quite a number of repeats of that performance.

MAPSTONE:

But by then you had something to sell.

KILPATRICK:

In 1961 when we went public, we had probably twenty, thirty, or forty people and were doing a reasonable amount of business and making profits. As a matter of fact, we always made a profit every year until the last fiscal year.

MAPSTONE:

That's awful. In the beginning you started with government work and then plotters reappeared.

KILPATRICK:

We started with government work, but as the plotters gradually began to sell we made a gradual changeover from government work to plotters. We developed a variety of different size and type plotters, and I think we were fortunate in the sense that the plotter business, up until that time, had been basically analog and now the digital computer was coming on strong. A digital plotter is just more amenable to working with a digital computer than is an analog plotter. And since our people knew digital computers and

understood digital circuits, programming, and things of this kind, were able to adapt that technology to the plotter business. Some of our competitor friends that were in the analog plotter business didn't have that kind of background, and I suspect that our early-day success in the plotter business stemmed from that fact.

MAPSTONE:

Of late, your company has gone into another direction; you talked about disks.

KILPATRICK:

Around 1968 or so, we were doing fairly well in the plotter business and had succeeded in raising enough capital so that we had cash in the bank that we hadn't quite figured out how to spend. A gentleman by the name of George Canola, who just left Scientific Data Systems -- maybe it was Xerox, I guess it was, because SCS had sold out to Xerox -- looked me up and said, "We want to go into the disk business if we could only find somebodyto finance it." So CalComp ultimately invested $1,300,000 in a new company called Century Data Systems headed by their goal was to go into the disk business. The first product they built was a disk of the IBM 2311 type, and very shortly after that a 2314 equivalent and a controller to go with it. From that start we've become very heavily involved in the disk memory business, to the point that well more than half our revenues today stem from that. With our initial investment, CalComp owned approximately two-thirds of Century Data and we had options to buy the rest. We now own about 99.7 per-cent of Century Data and are really in the process of integrating the two companies together. Our original plan was to build up an end-user sales and service force from the plotter business because we had some money.

Canola and crew alleged they could build a disk product, so we said, "Okay, you engineer and build it, and we will market and service it in the end-user world." We've done that relatively successfully, and I suspect today that we're probably the largest manufacturer of disk drives in the world other than IBM. We are currently building essentially all disk files that are used by Burroughs and UNIVAC. We sell a lot of them to other smaller OEMs, and we sell and lease them or similar products in the end-user marketplace in competition with IBM.

MAPSTONE:

Are you in direct competition with Data Products?

KILPATRICK:

Not really too direct. Data Products is primarily in the printer business, and although they have built some large disk files, about three feet in diameter, they aren't really IBM compatible. To my knowledge they have never built an equivalent of the 2311 or the 2314 or 3230.

MAPSTONE:

So they have tried to get another side of the market?

KILPATRICK:

Yes, but their main forte has been printers, core memories and things of that sort, probably more than disk files.

MAPSTONE:

I have just remembered a couple of things I didn't ask you about North American. When you joined and started to set up your department, did if have a name within the North American structure?

KILPATRICK:

At first we were two guys in an analog computer unit. At North American the first organizational structure was a unit, then a group, then a section. We started out as a unit, most of which was analog computers, and finally rose to the status where we were a digital computer unit, then a digital computer group and a digital computer section.

MAPSTONE:

Starting with the unit, were you in charge of the unit?

KILPATRICK:

Yes. I was in charge of anything in the digital development area that North American did from the time I started, when they were doing nothing, until the time I left, which was 1959.

MAPSTONE:

The other thing that you just mentioned briefly, which I thought I would come back to it, was some of the internal politics. I am interested in how they affected people and choices.

KILPATRICK:

That's a long story and I'm not sure I ought to preserve that for posterity. When I look back on it maybe I was as wrong as anybody else was and I don't want to name names or blame people.

MAPSTONE:

Can you be general about some of the effects it had on directions?

KILPATRICK:

I would say this. The whole time that I was at North American, from the time I started until the time I left, I was in charge of everything that was being done in the digital computer development areas. I started out with myself and Gene Seid and ended up with a fairly sizeable organization. This organization got bandied from pillar to post, first it was a part of this department, then a part of that, then a part of this and so on. That was all very fine with me, because I didn't care where my group reported as long as it was self-contained. In other words, if they had said to me, "How about if we move you one step up to where you are in charge of digital computers and something else?" I would have said, "Thanks, but no thanks." I wanted to be in charge of digital computers and I didn't want to have anything to do with analog computers or servos or gyroscopes or auto pilots or navigational equations or any of the other many things that they were doing.

The downfall of my relationship with North American probably stemmed from the time they were going to move my operation from one place to a different place, but I didn't particularly want to work for the particular man who was in charge. It was one of the few times that I cared one way or another. And be I right or wrong, our chemistry didn't mix and I didn't want to work for that particular person. I got the rumor of this impending change before it ever happened, as usually occurs in a big company, and I made it known that I didn't want to work there. As a result my group didn't get transferred over into that particular spot, but rather to a different place. As time went on, I had the feeling, whether correctly so or not, that my new boss had the portfolio of divide or conquer. Who's this guy Kilpatrick that's had a close-knit team of guys for so long that he is able to say who his boss should be? Big companies don't like that and I can understand it. I had the feeling that my new boss, although he was a fine fellow, had the portfolio to get the situation to a point where Kilpatrick didn't have such a tight grip on all of the technology that was becoming more and more important. I didn't like that, and I had to either win that political battle or lose it, which maybe I could have done, but it wasn't the kind of game I was enamored of playing. It was that climate and feeling, at least on my part, that made me susceptible when my friend Chisholm propped his feet on my desk and said, "How can you stand it in this big place?"

MAPSTONE:

When decisions had to be made about pursuing a specific direction, did you have to go up through the hierarchy, or was this pretty much your decision?

KILPATRICK:

By that time I was fairly far up in the organization from an engineering standpoint. I was a section chief and I guess there was one man between me and the chief engineer, or sometimes no man, depending on where I happened to be shifted for the moment. So that

wasn't too bad. Of course I had a proclivity through all these years of do it my way or else.

MAPSTONE:

[Laughter]

KILPATRICK:

As I look back, it must have been very frustrating for North American. For instance, we were building a digital computer to go in this missile and my view was, I'll build the computer and I'll build the power supply to run the computer all in one close-knit package. There were other people that thought since we were building a whole guidance system, we ought to have one power supply to run the computers and the gyros and the autopilot. In one respect this made sense; but why have a separate power supply for everything. Every time a new computer came along I fought that battle; I'm building the power supply in my computer and if you don't like it, you know what you can do about it. They always gave up and let me do it. The reason I took that view was because the voltage levels you needed in a computer that had many, many flip-flops and things like that, needed to be exactly what you can best figure out for those circuits. A digital computer has many circuits, and if you have the wrong power levels and the wrong this and that and the other, and use the wrong transistor, it just blows up out of all reasonable size in the power requirements. So I felt very strongly that the only way we could make a computer and have it work, because digital wasn't going to be there to see it through and if they when I wasn't going to be there to see to it that it worked that way? I can still remember the great surprise at old Les Kilpatrick getting soft.

MAPSTONE:

Someone should have seen the handwriting on the wall. When you wanted to buy a MADDIDA and a CRC, did you have to go through a great convincing job?

KILPATRICK:

Not in the early days because money was plentiful, it was all cost-plus-fixed-fee and they hadn't even gotten around to watching the budget on the cost-plus-fixed-fee, much less fixed-price contracts. In the early days money really wasn't a problem, and as time went on it pretty much stayed that way, because as contracting problems got tougher and the government got tighter, the things we were doing were more key and important and in essence had to be done if the whole project was going to succeed. I would say we were treated very nicely so far as our ability to spend money and do things. For example, we used to buy silicone transistors in sizeable quantities at $45 a crack when they first came out.

MAPSTONE:

What would have been the quantity of transistors in the NATPAC?

KILPATRICK:

NATPAC probably had in the order of 100-120 flip-flops, there were four or six transistors per flip-flops, so we used about a thousand transistors. **MAPSTONE:**By this time they would be selling for what kind of a price? **KILPATRICK:** For the kind we were using in the military systems then, well in the beginning they were very expensive, and as they would come down in price we would switch over to the newest, latest version which was up in price again. I would say we probably paid $30-50 a crack for a thousand or two transistors for the first silicone transistorized computers that we made, which were maybe two or three down the road. Then, of course, the price quickly came down. We used to pay one dollar, two dollars apiece for diodes.

MAPSTONE:

And you would use several thousand of those?

KILPATRICK:

A typical computer of the type we are talking about would have maybe a thousand transistors and five or six thousand diodes, somewhere in that range.

MAPSTONE:

So they weren't cheap machines.

KILPATRICK:

No. I can't even remember what the manufacturing costs of those machines were, but thinking back on their complexity, I would say we could probably build them for $50,000 or so, if we were building them in some reasonable quantities. Parts were much more expensive then than they are now. That kind of thing today with discrete components, you could probably build it for $5,000-10,000, except for the disk memory which was always a problem. It was a metal device that had to be lapped flat within micro inches, but it always scraped even so, and God knows how much money was spent on each disk memory.

MAPSTONE:

How about Floyd Steele? Did you have any dealings with him as a person or as a logic designer?

KILPATRICK:

Yes. Mr. Steele was the guy that sold us on the idea that we ought to buy a computer from him when he had just left Northrop. I didn't know Floyd well, but I knew him from his sales calls and from the nine or ten months that they were building the machine that we were buying. We gave it the most exhaustive environmental tests before we accepted

it, and we had them pinned down to meet temperature tests, vibration tests and everything else on the machine, which really was kind of foolish. Before we paid for the machine we put it in an altitude chamber over at North American, Inglewood, ran it up to a high altitude, down to a low temperature and up to a high temperature, put it on a big vibration thing that was used to shake gasoline tanks and shook the hell out of it, and it passed every test hands down. Then we accepted the damn thing and it never worked again.

MAPSTONE:

[Laughter]

KILPATRICK:

Basically, this was because we weren't as familiar with the detailed logic and circuits as the CRC people were, and the diodes popped out at a faster rate than we were able to change them. I guess the thing ran at times. The logic was all right, but the few thousand iodes were a problem. If you could get all good diodes in it at one fell swoop, then it would run for a day or two before one of them cracked up. However, if you took very long to find that one, by the time you did another one had gone out. **MAPSTONE:** I guess the way the machine was laid out made it difficult to find the faulty diode. **KILPATRICK:** It was very much a serial machine with everything multiplexed and combined into one logical structure, and it didn't have many of the diagnostic techniques that exist today. So finding trouble required some ingenuity.

MAPSTONE:

It must have been pretty important to have really checked out the machines that you were building to fly the missiles. What kind of methods did you go about to do this?

KILPATRICK:

We went to great extremes to try and design equipment that would be reliable and work well. A typical missile flight time was five to eight hours. To get everything ready it had to work some time before that, and to get a computer that would run for ten hours in a row and never miss a beat was pretty tough. The way a digital differential analyzer worked is that if it misses one pulse it remembers that data is lost forever. For instance, if you were blindfolded in a car and you were keeping track of where you were by sensing the accelerations and turns, and all of a sudden someone knocked you out for six blocks, you would have no way of knowing which direction you were going when you woke up. These computers had the characteristic that if they ever missed anything, it was gone. We went to great lengths to try to select the best parts, and to age and test them under power and things of that sort.

MAPSTONE:

By aging, you mean you find out the life of a given part?

KILPATRICK:

In those days transistors had a bad failing in that frequently the cases weren't sealed and they would get moisture in them. We would dunk them in water for days, and run them in life tests with power applied, and vibrate them a little bit in hopes that if they had a seal that wasn't quite good, it would fail while we were testing it rather than afterwards. So we went through all those processes of trying to test and select parts that were reliable. Then we did our best to design circuits that had wide ranges of tolerance, which I guess everybody did in the computer business. An inertial navigation system is really a very complex device consisting of gyros, accelerometers, autopilots, computers and all kinds of things. The computer part was only a part of the very complex electronics. In the early days when we first had digital computers as part of the navigation system, a breadboard test would be to put them in a truck and drive them around to see if they could tell where the truck is. The driver would look out the window and say, "We're at the corner of Lakewood and Imperial, what does the computer say?" In the early days if the system failed, which it usually did very quickly, everybody always assumed it was the computer's fault and they were usually right. As time went on it got to where it was a toss-up, and then we got to the point where when the system failed they assumed it wasn't the computer even though it was upon occasion.

MAPSTONE:

[Laugh] Somebody was telling the story just the other day about how on one occasion he finally convinced everybody that a mistake that had been made was definitely the computer's fault. He got his machine time given back to him, but as he was walking down the hall he suddenly remembered that there's one thing he didn't check. He checked it out and discovered it was his mistake, and he was made to get on a table and apologize to the computer. [Laughter]

KILPATRICK:

Modern computers make many errors that the user isn't even aware of. You know if they make a mistake in reading tape they go back and try to read it six times, and they've got error checking, and error correction and all kinds of things. In a missile computer we didn't have a chance to go back and try to read it over again. If it missed, it missed. We couldn't afford the weight and the power of redundant circuits, error checking and correction, and things like that, so one miss and we were out. I think even the modern computers of our dear IBM friends even, if the whole thing was aborted, if it ever dropped one bit, I think things would be in pretty tough shape.

MAPSTONE:

One other thought that we talked about a little bit earlier, and that is the East/West Coast dichotomy. We know that the East and West didn't see eye to eye and that they had different ways of designing computers. I was wondering, though, if this rift had any other

significance or if it in any way caused problems. Is it possible that the West Coast people did something one way, not because it might have been the best way, but because they wanted to show their friends in the East that they were independent?

KILPATRICK:

Well, about the only difference that I was aware of in those days was that we did everything by logical equations and the East Coast guys always drew a bunch of block diagrams. They had asynchronous type machines; ours were synchronous. You put in one clock pulse and everything changed, clunk. You put in another clock pulse and everything changed, clunk. We didn't have asynchronous operations of pulses where everything would ripple through like you get in the carry-over of a parallel adder. All the computer work on the West Coast really came out of the aerospace world, people were working on building small, portable type machines. I think by the nature of the kinds of problems that we were trying to solve, that logical equations and diode logic were more suitable to that class of machines. Of course our assumption was those dunderheads on the East Coast just didn't know what they are doing, and vice versa, I am sure. Perhaps if we had had to change places we would have changed philosophies.

MAPSTONE:

How about hiring across lines? Did a lot of eastern people get hired out on the West Coast?

KILPATRICK:

I would say there was very little hiring of computer people from places like IBM and UNIVAC in the aerospace company where I was. Basically we hired new graduate engineers and trained them from the ground up. We didn't go out and look for a computer expert that had worked for IBM for five years. We should have, in hindsight. We went to the universities and tried to hire their brightest young graduates, who probably didn't know anything about computers, but had a good engineering background. It's quite different in the commercial world today. A company of our size, which isn't that small any more, doesn't recruit new graduates but hires a guy that's been around a few years. I guess we are about to get to the size where it might pay us to go out and hire a brand new engineering graduate who would be doing something useful in two or three years.

MAPSTONE:

That's interesting. I wonder who is hiring the engineering graduates? Where's the market?

KILPATRICK:

Primarily it's the large companies. A company like ours which has roughly 3,000 people, of graduate engineers who work all day long at their profession; not engineers that become salesmen or managers, of those 3,000 people, may have only a couple hundred may be engineers. And these people are all very busy on very important things that we want to get out quickly before it's too late; so it's kind of expensive to hire a new graduate at two-thirds of what it might take to hire an experienced man and train him while you're waiting to get your product out.

MAPSTONE:

Going back to hiring from the East, one of two people who have come out here have said how difficult it was, and that there was a real hostility from people in the industry just for the very fact that they came from the East. I suppose this is something that's far more deeply ingrained than just in the computer industry.

KILPATRICK:

I don't know. We hired engineers in the early days of North American from all over. I used to go on recruiting trips to Yale, Harvard, Princeton and every place in sight, and we'd do our darndest to hire the brightest engineer they had coming out of school. We didn't go back and recruit among the established companies, and we should have gone back to IBM and hired their brightest guys.

MAPSTONE:

Was it a case of honor among thieves?

KILPATRICK:

I don't think it was honor, we just weren't bright enough to think of it. Maybe RECOMP would have been a real success and North American would have been where IBM is and vice versa, if we'd only been bright enough to hire a guy who really knew the computer business. Not the technology of building the computer, but how to build what the user needs and wants and how to sell it. I'm afraid that we weren't really hip to the fact that there's a difference.

MAPSTONE:

It's taken a long time for that to really become apparent. It must have taken almost fifteen years I would say, since the beginning of computer development, to develop real recognition by non-IBM people that this was the way to go.

KILPATRICK:

Yes, and it's only been in recent years even here at CalComp that people like myself have realized that just building the best project isn't sufficient. It's the price of entry, you've

got to have a good product, but it's far from sufficient. Sales and service and all those things are equally, if not more, important than just having a good product. It's hardly sufficient. Fifteen years ago I didn't know that like I know it now. I don't think our dear friends IBM have ever been accused of having the par excellence, latest, best, red-hottest technical products, the place they've always won is having an acceptable quality product and the world's greatest sales force.

MAPSTONE:

They've rarely been on the cutting edge of technology.

KILPATRICK:

Very rarely on the real cutting edge. Of course, maybe they were, but why bother to bring it out?

MAPSTONE:

There's a curve of the way they seem to have worked, which is: let there be enough of a demand for something and then we'll make it. Whether it's always been planned that way, I don't know. For instance, the 702, there were inner battles before --

KILPATRICK:

Of course, since I've known IBM in the computer business they have been primarily a lease-oriented company. They always had masses of computers out on lease, and I think any businessman faced with that situation isn't going to scrap that entire inventory just because he's thought up a little later, red-hotter product, unless competition compels him to. Why scrap three thousand machines in the field that are bringing in good rental just because you have thought of a three percent better technical way to build it? It just doesn't make economic sense. Now a company that didn't have that base could afford to take their latest thing out of the research lab and say here it is. They don't compete with themselves if they don't already have the base there. A company like ourselves now gets into that position to a certain extent. If we're building a product and it is in the field and we have three hundred eight months, through the production line for the next we're hardly going to bring out something that obsoletes it, at least not until we get through with that production run. We wouldn't be around if we did.

MAPSTONE:

No. That would be the Charles Babbage syndrome - not finishing something. That was the Floyd Steele syndrome too in many ways.

KILPATRICK:

Yes, Floyd was always so far ahead of everybody else that he had trouble settling down

long enough to build the old thing when he had a new and better one in mind. At least that was my impression of him.

MAPSTONE:

Did you have any dealings with his Tabula Rasa concept?

KILPATRICK:

Which was this?

MAPSTONE:

Tabula Rasa. He had a concept for a micro-programmed machine very, very early. In fact that was the reason for the split at CRC; he wanted to build this machine and the rest of the guys said no, we've got to finish the one we're building.

KILPATRICK:

The rest of the guys wanted to finish the one they were building for us which was their only contract, and Floyd probably was ready to start on the next one. He had the, "Why bother with this one?" syndrome. I wasn't familiar in detail, but I talked to Floyd back in those days and he was always two steps further down the road.

MAPSTONE:

Did you ever know Glenn Hagen and have any dealings with Hagen?

KILPATRICK:

I had a reasonable amount.

MAPSTONE:

When you bought the MADDIDA?

KILPATRICK:

Well, I think Hagen was the guy that was left over at Northrop when Steele and everybody left to start CRC. Hagen was left with the dregs to try to put the machine together, and he did. Shortly after that he left and I can't remember all of those sequences. I knew Glenn all through those times. He was one of the earlier buyers of plotters, and sort of got Seid and Morton started.

MAPSTONE:

Oh, really? That would have been when he had ALWAC, Logistics Research?

KILPATRICK:

Yes. I knew him then.

MAPSTONE:

He's one of the most colorful people in the computer field from those early days.

KILPATRICK:

Yes, I haven t even heard of him in recent years. He is certainly one of the people you should interview if you haven't.

MAPSTONE:

I want to.

KILPATRICK:

He got money from Sweden or somewhere.

MAPSTONE:

From Axel Wenner-Gren.

KILPATRICK:

He was riding high for a while, and he was a very creative guy.

MAPSTONE:

Les, I think we have covered all the points that have come up while we've been talking. Can you think of anything you would like to add or thoughts that occurred that I didn't get to?

KILPATRICK:

I can't really think of anything that we haven't covered to the extent of what I can remember or can shed any light on.

[End of Tape 2]

[Start Tape 3, Side 1]

KILPATRICK:

The people at Litton decided that they could make a commercial product out of a digital differential analyzer, and they built a very small, 22-integrator machine. Their plan was that every engineer would have one on his desk to solve differential equations. They decided that Seid and Morton who had started CalComp at that time and had a digital plotter, were the only source of digital plotters. Since they were a very small company consisting of two employees, Litton ordered lost of plotters so they could get them out in time to meet the great demand for digital differential analyzers on engineers' desks. For a time CalComp probably had orders for twenty or thirty plotters, and they made a little money. When the Litton approach to solving the engineering problems of the world bombed out and nobody else wanted a digital plotter, Gene Seid left CalComp and came back to work for me at North American, one other engineer, a fellow named Bruce Sawyer, also left, leaving Bob Morton as the sole proprietor of CalComp. When I say one man company, I didn't mean one man who rules with authority -- I mean one man who was it. Bob Morton was a very good mechanical engineer, but it was not his temperament to be a salesman, and he fell into the habit of sitting around his thousand square foot shop waiting for somebody to order a digital plotter. It was about that time that Gene Seid, Ron Cohen [?], another gentleman that worked for me; Gene Beckman, who was a lawyer-type with North American, and myself decided that we didn't want to work for a big company all our life. So we ended up forming a partnership with Bob Morton which really started CalComp in its present vein in about 1959, although it had existed as a company for several years prior to that. When we left North American we weren't particularly enchanted with plotters as a product, in fact, nobody had ordered one for years. We didn't start the company to build plotters, we started it to go into government contract development work, and that's what we did for the first few years. We would rush out and bid on the contract and develop the thing on a cost-plus-fixed-fee basis. However, we did have this old plotter lying around that nobody had bought and we gradually polished it up to where it worked better and we sold a few to Bendix, who had built a different version of a commercial digital differential analyzer. Eventually they began to order more and more plotters and we couldn't believe that they were selling that many digital differential analyzers.

We did general purpose computer and creating using it on their purpose whole value basis. increments from the general of them and gradually We began to sell more and more oriented to the plotters as our business became more we found we could make more money on that than we could on government contracts. Finally switched over to where we put more emphasis on the plotter business than we did on the government contracting business.

MAPSTONE:

Are you still involved in plotters?

KILPATRICK:

That's the major area that we're involved in. At the current time we make ten or fifteen kinds of digital plotting devices and drivers -- small computers to run these plotting devices -- and things of that sort, and we do a lot of software work to make them easier to use. CalComp has been, I think, over the years, the leading company in the plotter field. In the last three or four years we have also become very heavily involved in building disk files and now tape drives. Our sales volume this year will probably be somewhere in the $70 million range, and maybe a third of that or so will be based on plotters, the rest of it based on disk files, tape drives and things like that.

MAPSTONE:

It's still quite a major part of the business then?

KILPATRICK:

Yes, it's still a major part of the business.

MAPSTONE:

What were some of the early government contracts you had?

KILPATRICK:

We got a contract from our old friends at Frankfort Arsenal to build a display device to go along with the FADAC artillery fire control system. They needed a digital read-out that would give you the elevation and all the different parameters it takes to fire a cannon. It would take the data from the FADAC computer and display these in numeric read-out form so the artillery guy would know how to aim the cannon. This contract to develop a display device, which was the first we got after we started the business in 1959 was, I believe, for $100,000 cost-plus-fixed-fee.

A little later on we got a contract from NASA, which had come into being by this time, to develop and build a command system for the Nimbus satellite -- the weather observation satellite system. It was almost a $600,000 contract from NASA to build a basic command system, which was really a glorified alarm clock. It keeps track of time based on a crystal oscillator that was counting down, and you can set the alarm to ring any one of a multiplicity of bells at different times -- so it's like a generalized alarm clock, it keeps track of time but you can set the alarm. If you have maybe 128 different alarms that you could set for different times and use them in the satellite to turn off and on tape recorders, cameras and things of that sort, as the satellite goes around in orbit. That was the second contract, big contract, we got and again it was on the cost-plus-fixed-fee basis. We built the business from essentially nothing up to a couple million dollars a year on those kinds of contracts. We were building digital type devices that weren't really digital

computers but used the same technology, and we could get government agencies to give us work based on the fact that we had people that were right in the forefront of transistorized digital technology. As I said, we gradually found we could make more money with plotters and I would say around 1962-4 we switched over to where our real emphasis was on products, primarily plotters in those days, and less on government contracts. At the present time we do almost no work on government contracts; we sell plotters and disk files to the government, but we are no longer in the business of pursuing government contracts.

MAPSTONE:

Going back to FADAC a minute, didn't North American lose the contract to do it commercially?

KILPATRICK:

North American didn't get the production contract for the artillery application. Teledyne got that contract, and CalComp got a production contract to build a piece of test equipment to test the FADAC computer. This test equipment device, called the FALT, was a small special-purpose computer that operated from punched paper tape input, and was used to exercise all of the flip-flops in the FADAC. You could set up any given logical proposition from this punched paper tape through the FALT plugged into the FADAC. For instance, you could set up all the logical equations in sequence, put in the same clock pulse, and check to see if the flip-flop that should have changed state, changed state. So it was a small box of a few cubic feet that looked like a small computer with the same technology. CalComp got a production contract to built between 60-100 of these FALTS, which the people at Frankfort Arsenal had redesigned for production from the days we developed the first prototype at North American.

MAPSTONE:

In a way it made sense for them to come to you.

KILPATRICK:

Particularly since when they redesigned for production they succeeded in making about as many mistakes as you possibly could, and what they came up with is production drawings completely incapable of working a machine which from the time it goes to the government agency starts to go downhill.

KILPATRICK:

I'm sort of sympathetic to some of the problems we hear these days about Lockheed and other places that have big government contracts. The government says build it, it's your problem, and the company says, but I'm going to lose $500 million. We had a very good example on a small scale withis FALT computer tester. We knew all about the project

because we had developed it originally, the government redesigned it for production and we had bid on it as a fixed-price production contract, theoretically just building it to print. However, when we looked at it with the engineers who had designed it originally, they said, "Look, it won't work if we build it that way. This tube's in upside down, this transformer isn't hooked up, this transistor's going to burn out, this wire list has got power hooked on to everything in sight." We set forth to redesign it so that it would work, on a fixed-price contract, and we were led to believe by the government that they would cover all of the changes required if we'd only solve the problems they'd take care of us. When we had solved the problem they took care of us by saying, "Deliver price. The changes you've made which cost lots of money shouldn't have cost anything like that, they should be far less." We came very close to breaking our company to get out of it at that time.

MAPSTONE:

That's all a small company needs to do it in.

KILPATRICK:

We had a problem in the beginning. If we built it to print, we knew it wouldn't work, so how were we ever we going to going to get paid? If we change it, are get paid for the changes? I remember one case in particular involving a basic casting on the machine. Theoretically, we needed to place the production order with a vendor to build 100 castings, yet it was painfully obvious if he built them they would all be scrapped. What do you do? Do you build it to print when you know it won't work or do you try to get a change and then try to collect the costs of doing so? Needless to say the Arsenal people were very embarrassed that their production redesign wasn't too good, and we got into a political hassle on that score. I think when people look back historically at government policies over the past ten or fifteen years, that there were really fundamental problems. If somebody is given a contract to build quantities of an item that man has not yet designed and hardly conceived, and you expect it's going to cost or even if it can be done, and where you're going to hold them to a maximum profit of a few percent by government renegotiation and everything else, but you're perfectly willing to let them lose five times their original contract if things don't work out, that's intolerable. The cost-plus-fixed-fee contracts were abused, there is no question about that, but the fixed price government contract to build to print specifications, particularly if the prints aren't even around, is equally impractical. You can't build a vehicle to go to the moon on fixed-price contract and know what to bid.

MAPSTONE:

The system's got some rot in it, hasn't it?

KILPATRICK:

Yes, it's a very awkward system. So what's really happened over the years is that the

most talented companies and people who could find another avenue are off doing something else, they're not doing government contracting work anymore. Our company is an example. Although we were a very small company we had some very talented people, and we used to look for every opportunity we could find to bid on government contracts and do our best efforts to write a good proposal, get the contract, gradually gotten out of that and do the job. We have habit, and today we don't even look for such contracts and if somebody came in and offered us one, we would say, "Sorry, we're too busy."

MAPSTONE:

I suspect it hasn't changed, has it?

KILPATRICK:

Not really. Take the C5A Lockheed situation. Although I'm not familiar with it, when I read the paper I just know what happened. There was a fixed-price contract to build all these giant planes that nobody ever built before and they were told by the government that if it cost more than the contract, don't worry about the changes, we'll take care of you. Then, by the time it got time to take care of the, it was a different kind of taking care of. That doesn't mean to say that Lockheed may have been horribly inefficient and what have you.

MAPSTONE:

Right. From both sides the system was inefficient.

KILPATRICK:

The government had a great proclivity in those early days to tell us how much to bid based on the money they had available. For instance, if we bid $150,000 they might suggest that we cut our bid down to $100,000 with the knowledge that if it doesn't work out and there are changes they'll be taken care of and funded next year. So the government has been party to low bids.

MAPSTONE:

The companies have been party too.

KILPATRICK:

Yes, the companies have been party, too, because they thought their old friends would take care of them and vice versa. It's been very bad. There have been companies that deliberately bid low to get the job, thinking they could make it up through changes. Neither side is blameless. However, you can't do real advanced development work on a fixed-price contract unless you bid it at many times what you think it's going to cost, which government scheme. So the McNamara is tolerable in the era of do everything at

fixed price is intolerable, intolerable perhaps as in the early days when just as I started working on the Navajo, when everything was done on cost-plus-fixed-fee contract with nobody caring what it cost.

MAPSTONE:

I suppose the only way to really get into future technologies, build something that's never been done before, is to have pure research and development groups set up where somehow or other the funding is continuous.

KILPATRICK:

A good example is the Bell Telephone environment, where AT&T can afford to have a group that sits and thinks and not really expect them to do anything, but yet they come out with such things as the transistor.

MAPSTONE:

Yes, such small gems as that.

KILPATRICK:

There's a great deal of difference between research, which knowledge with no thought of practical application, and development, where once you know something can be done take the knowledge that is there and try to , you adapt it to a useful end, but that phase of development is still a very tenuous, loose flowing thing.

MAPSTONE:

Yes

KILPATRICK:

It's very hard to define exactly where you are, particularly if you are working on newer frontiers in technology. You may think you are to the point where it can be developed or produced, but you are not quite there yet, particularly if you are striving for something beyond the present state of the art. In weapons systems which get very complex, generally each new system is a significant advance beyond the existing state of the art. The people may be sure that they can do it, but they're not sure exactly how or what it's really going to cost. You can't really economically -- in the long run - do that kind of work on a fixed-price basis.

MAPSTONE:

It's surprising that large organizations, or small organizations, are willing to do government work.

KILPATRICK:

Well, they all do whatever is the best they can at a given instant, but there are far fewer people willing to do government development and production work today on things that they are not very sure of on a fixed price basis. My company isn't.

MAPSTONE:

You wouldn't touch it with a barge pole?

KILPATRICK:

We wouldn't touch it with a ten foot pole. People are limited on government contracts by the way it is negotiated in the first place, to where the maximum profit they are supposed to make is between five and ten percent. There is an excess profits law that says if they should happen to luck out and make fifty percent, it will be taken away. Anybody doing government contracting of over a million dollars a year is subject to re-negotiation. This was put in during World War II on the grounds that there wasn't time to plan. ... So you are clamped as to the maximum you can possibly make and yet you are not clamped as to the amount you can lose.

MAPSTONE:

So either the control should be both ways or neither? It's really a double standard, isn't it.

KILPATRICK:

In the commercial computer world people develop things on their own money, they build them in production when they think it's ready to go, and although it may cost the company a fair amount of money to get there, typi cally you sell things at three, four, five, even ten times the manufacturing cost. Typical computer mark-up for people that are successful is probably four or five times the manufacturing cost, so if you make a few errors in the development process and if it's really a good product, you can get well pretty quickly. I'm not saying you make that much profit, because there is overhead and research and sales cost and all those things, but the bare manufacturing cost to the marketing price is anywhere from 2-1 to 8-1 in the commercial computer world.

MAPSTONE:

Which is fair and understandable. By the same token, I suppose the government must also watch out for companies making very heavy profits off the government. Because that somehow doesn't ring quite right.

KILPATRICK:

Of course, if you get into a big missile or something of that kind like the Navajo or the Minute Man, the government can't stop mid-stream and give it to somebody else, it's impossible. So there has to be a protection. You shouldn't make five times your money on a missile contract, but neither should you take the risk. Really the people working on it are government employees, whether you call them that or not. **MAPSTONE:** If the project the government wants done costs twice as much, they should be required to pay for it. **KILPATRICK:** They should pay for it, they should monitor and control it, and decide if they really need that little extra gadget or gimmick. One of the real problems is that in the newer areas of technology it is very hard for the government to hire and pay the kind of talent they need to even monitor, because they are stuck with civil service wages and things of that kind, and a really talented engineer probably wouldn't want to work for that pay unless he just happens into it and likes to be in government service.

MAPSTONE:

Let me just backtrack again. We just briefly touched on Litton, and since I haven't really made any contacts with Litton and I'm not too sure about what went on, can you tell me what you know and drop some names if you know some.

KILPATRICK:

I didn't know the people at Litton very well. They started working on computers a little later than North American and Hughes, but they were doing a fair amount of work on military-type computers and things of that sort.

MAPSTONE:

Do you recall any names?

KILPATRICK:

A fellow by the name of Thorn, I believe, was in charge of some of their computer work.

MAPSTONE:

Do you know his first name?

KILPATRICK:

I believe it was Jack Thorn.

MAPSTONE:

Do you know anyone at Litton now who might be able to get me in the door?

KILPATRICK:

I could probably find someone fairly easily.

MAPSTONE:

That would help. You know, it's impossible to call a company and say, "Hey, I'm interested in this," and get to the right place.

KILPATRICK:

Jim Pyle could give us some information, because he knows everybody that ever was anywhere.

MAPSTONE:

That's good. I think we have really covered quite a lot of territory.

KILPATRICK:

We've covered about all I think I can remember on the spur of the moment.

MAPSTONE:

Okay, let's turn the tape off.

[End of Interview]