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TAPE RECORDED INTERVIEW PROJECT

Interview with Verner Suomi

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Interviewers: Gisela Kutzbach et. al.

Kutzbach: ...I'd like to talk with you about your background: something about your parents, and where you were brought up and how you were brought up.

Suomi: I was born in _____, Minnesota, up in mining country. My parents emigrated into the United States in 1902. I just happened to read it in a Finnish newspaper, of all things. I was part of a family of seven children, one brother and the rest sisters. I always complained that my sisters had two brothers and I only had one.

Kutzbach: Were you the youngest?

Suomi: I was the youngest son, but not the youngest in the family. I had a younger sister than myself. And we lived on a--it wasn't a farm, it was a little of about seven acres, and there were agricultural chores to do and we had to get in the hay and we had a garden, a pretty extensive garden. We did a lot of canning, my mother did, and the girls, so that we would have groceries throughout the year.

Kutzbach: How big was this city or town?

Suomi: The city we lived in was called "a location." Its name was _____-Stratton Location. I go up there now and I can't find it because an open pit gobbled it up; it's just air. And that hurts. It's amazing how much it hurts just to see air.

My father was a carpenter so I had tools to use. That was very helpful because I liked to build things. You go into a store today, you buy a child a toy, it's made of plastic. The child didn't have to build it. I had to build them. I cut spools of thread in half and I made wheels--

Kutzbach: Did you go along with your father? Did he want you to do this, or did you just--

Suomi: My father worked so hard, ten hours a day, so we didn't do too many things together. He was just exhausted. But he let me play right near the house; we had

a little garden and I used it to dig with, I made a little steam shovel patterned after the big ones. He got so disgusted with my digging in his garden that he went some distance away in our yard and made a new garden so I could have that one to play.

He took care of us, provided food and clothing and very adequate things. But he didn't have time to relate to us in one-to-one relationship. My brother, whose name is Anard, was nine years older than I was, and to a large extent, he took my father's place. He did a lot of guidance, he was great fun. So much of my philosophy of life and so on stems from him. He and my father didn't get along too well because my father was no longer working for the mining company even though he was a few days from having a 25th anniversary and would have gotten a pension, but something came up, so my brother was the breadwinner. This was during the Depression, of course, when there was no employment.

Kutzbach: So your father quit the job?

Suomi: He was fired, I guess. Maybe he quit, I don't know. But I would tell my brother, "Why don't you go someplace? Why don't you go out for yourself?" And he said, "You're supposed to honor your father and your mother." So those things have stuck with me for a long, long time. He gave many of those wonderful lessons. Of course, when I got in his way and got into his tools, or screwed up something he had...one time he threw me over the little pea garden fence...

Kutzbach: So what did he build?

Suomi: He had my father build what was called a bunkhouse; it was a separate building from our main house. We enjoyed the spring, fall and sometimes even early winter living there. So we were together quite a bit in this little bunkhouse. It used to be the neighborhood headquarters also, so we had all our friends, people would come to our house--we didn't have to go to theirs. This experience was really very beneficial to me, in terms of how I relate to other people. Friends go a long, long way, and a sense of humor goes even further. That was very helpful.

Kutzbach: And there was a wide range of ages?

Suomi: Yes, a wide range of ages, languages, sometimes I would wake up--my brother worked night shift--and I would have a complete stranger in my bed. Well, he had no place to sleep, so my brother said go sleep in the bunkhouse, so there he was. Life was full of that. He stressed education, my brother. He was unable to complete school because of financial problems, but he wuld have been a great one if he did.

Kutzbach: Where was school there?

Suomi: The school was in ?Evelis, Minnesota, and the point there--a very important point--is that the schools were absolutely superb. You see, with the mines there, there was a tax called the *ad valorem* tax, which gave even a little city like ours, which was only 9,000 people, a remarkable budget. So we had machine shops and glass shops and printing shops and electrical shops, woodworking shops, auto mechanic shop--during the course of my education, I took these courses where you learn how to use your hands, which was very important. As well as debating team, basketball, all the rest of it.

But when I first went to college--I went to junior college there for two years--when I first went to college later, the tools which we had in the college did not live up to what we had in the high school.

Kutzbach: So that's because it was a mining city, and there was not that emphasis--

Suomi: It was rich, so the schools were rich and a rich school is better than a poor school, and the teachers were wonderful.

Kutzbach: So you learned your building skills in school, then...?

Suomi: I learned them in both. I learned them at home and I learned them in school. We had a radio club, we had an aviation club, we fixed cars and drove them around in a little lot there. As a matter of fact, there was an old airplane motor, an old X-5, which used to be a Liberty engine, that hadn't run for five years. So in one of these courses I took it upon myself to, with, of course, the permission of the instructor, to fix the darn thing. And after working a better part of a semester, it was mounted on a rack so that this propeller could spin up above the ground and you could crank it much like an airplane, but it didn't have the rest of the airplane. And I actually got that started, and I can tell you that that was one great big thrill. It really was. So...

I had a wonderful youth, just absolutely incredible.

Kutzbach: Was there any teacher that you remember?

Suomi: Oh, yes, I remember a Johnston, who was part of the radio club--he actually taught drafting, but he also had radio club. And I had a fifth-grade teacher, I think "Miss Cippela," and she sent me into the cloak hall many times because I was doing things I wasn't supposed to be doing. But she was understanding, too. She was a great one. And we had Miss Hall, who taught us literature and English. She made us work hard, but it all turned out very well...

Kutzbach: One more question about your school. How many grades were [in] that school?

Suomi: Twelve.

Kutzbach: So it was all in the same school...

Suomi: All in the same school, and as a matter of fact, it went even further than that because parts of the building were junior college. So it fit altogether right away. ...I took all the math courses, and so that when I left, they allowed me to take calculus, even though it was college credit, while I was in high school.

Kutzbach: So in that junior college, you could already attend those courses. How wonderful.

Suomi: Very good school.

Kutzbach: So did they give you some counseling, like Mr. Johnson or anyone?

Suomi: It wasn't so much counseling as much as encouragement. I wasn't any trouble, so to speak, but they could tell that I was interested in stuff so they gave me an opportunities to follow that interest...

So I didn't go much for athletics. I appreciate basketball the way everybody in this town does now, but I enjoyed learning things more. I don't think you could say that I was doing research as such.

Kutzbach: Now when you say your father said, "Honor your parents," did you have any strong religious life at home?

Suomi: Oh, we had a strong religious life. We were Lutherans and went to church every Sunday, and then Sunday School. My brother fought it a little bit, but he came around eventually after he was a teenager. We still attend church here. In the last much of the year, we could have followed the medication schedule--it doesn't fit the church schedule very well. So we're on the side, more or less, listening to t.v.

Kutzbach: My mother was a remarkable woman...[brings photograph]...my mother, you can tell from the bedroom slippers, you can tell that she was completely bedridden with arthritis. They didn't even know of the effects of aspirin and how they would be beneficial at that time. So despite the fact that she was bedridden, she had good control of the family, and of course that gave much of the work to my sisters, and each of the sisters would gradually go away and become a domestic somewhere in Chicago--I guess most of them moved to Evanston--and of course that gave them a little money. So they were sending things back to us as gifts, and of course to me, when my brother gave me an erector set with an electric motor. Wow! I don't know, I think I was probably ten. I can't recall. But that was absolutely wonderful. I used every part in the thing and then some.

So the basic educational opportunity for me was **very** high. I just liked it and soaked it all in. It has had an impact on me now because at that time, if you were building a toy, you had to get it done, you couldn't use it unless it was done. So that has had an impact on my later life. If I'm working on a satellite, you've got

to get it done. Working on this thing which floats on the ocean, we have to get it done.

Kutzbach: So you always had that attitude of toys, too?

Suomi: Sure. Finish the thing, it's a toy. I enjoy it eventually. I've got a computer in here running calibration in my bedroom right now. So nothing's changed.

Kutzbach: So those interests were really all-consuming at that time. You didn't have any, let's say, music or so in addition to that.

Suomi: No, I didn't have any music. When I came home from school, there were chores. We didn't have water in the house. We didn't have electricity. You had to go and get water from a fount, oh, maybe--distances can fool you as a child. But eventually we got water, but no toilet. I'm telling you, when it's cold outside, that's an experience.

Kutzbach: So did you invent anything for your home or not?

Suomi: Oh, little things like shelves and things that things hang in. We had an old Model T car which my brother and I kept going by repair and so on. Because I had auto mechanics, we could even make the bearings in the car. Nothing held us back.

It was not a rich life, in terms of having a lot of financial help. But I was adequately clothed, I was adequately fed, we had cows we had to take care of we butchered. So the range of experience was very great.

We also in the evenings had our own _____ in teams. There were two streetlights so we played games like hide-and-seek, those typical games. So there was lots of spirit with other children. We gradually had our own ball team, so I played baseball but not [as] part of the school activities; it was our own team.

Kutzbach: Was there anything ethnic? The Finnish _____

Suomi: We lived in a village [where] there was one other Swedish couple. We were considered Swedes, not Finns. The rest of them, maybe about twenty families or so, were Italians. So they knew how to enjoy life, make wine and things like that, so every Christmas they would give us one of their best wines and my father was wise enough to [say], when asked, "Whose was the best wine?" He said, "It's all so good I can't tell the difference." Otherwise it would have been a political mistake. We had a good time. It was basically a happy family.

Kutzbach: Wonderful.

When you were in twelfth grade, and you were thinking of what you should do next, what--did you have a dream or did you, what happened then, how did you plan the next step?

Suomi: This is the person right there who said [pointing to photograph]--

Kutzbach: Your brother.

Suomi: My brother. My tuition to college was only $14.00, but it was the middle of the Depression, you couldn't find a job. He said, "I will put you through college, but you have to earn the first $14.00 first." And so, I mowed lawns, I did everything to earn that first $14.00, but he supported me fully while I was in junior college, and even when I finally went to college at Winona.

Kutzbach: So the junior college was the one next to your high school.

Suomi: Yes. Then I completed college, I don't recall that I was a superstar pupil, I wasn't a dumb one either, but after--

Kutzbach: What did you major in?

Suomi: I majored in math and science. And after junior college was over, there were no jobs, no nothing, so then I joined the Civilian Conservation Corps and went there for about fourteen months. In the beginning, my job was to take of the light plant and water pumps and all of those because my training in college, as well as in high school, was about mechanical and electrical things. Then afterwards, I became the assistant to the camp educational advisor, so I stayed in camp. I was trying to avoid going out in that cold woods working...I escaped that.

The person who was the camp educational advisor turned out to be John A. Blotnick, who was from Chisholm, a wonderful person, interested in policy and education and things like that. And after I left the CCC, he got a job, I think it was, in some educational office, either in the county or in the state. But he eventually ran for Congress, and became the Congressman for the 8th District of Northern Minnesota for many, many years. And while I was in the CCC, he had gone to Winona Teacher's College and he got me a scholarship, and so that's what made it possible for me to go to college. If it weren't for John Blotnick, I wouldn't have come.

So I went one year, then I took one semester off and took a Civil Service exam for work in the Forest Service. You see, in the CCC, the Army took care of your living aspects when you came in camp at nights, whereas in the morning after reveille, you were turned over to the Forest Service. You went out into the woods to work, and then at 5:00, you would be checked back in. So, just for the devil of it, I took a Civil Service exam for the lowest job I ever had, which was junior assistant technician. They don't come any lower. I passed it without a single

mistake; in that exam, the questions were obvious. Any boob could do it. So I worked. I left school for one fall and winter--

Kutzbach: That was after you had completed one year.

Suomi: One year of Winona. Then I came back and finished off. I was in class plays when I was in Winona, I liked that, and that's where I met Paula.

Kutzbach: I see. Just one more question about college. So you didn't really go there because you wanted to be a teacher. It's because there was this fellowship.

Suomi: That's right. But there were some excellent teachers there. And I always had a guilt complex about being able to go to school when my brother was not able to go to school because of financial purposes. When I graduated in the summer, I didn't feel comfortable. I complained about that to my brother, and he was wise enough to say, "Don't worry about that. When they honor you, they honor us."

Kutzbach: He was wonderful.

Suomi: He was just full of that...I was very fortunate to have him as a brother. So in a sense, he carried much of his experience in college, he was on the debate team, he played hockey. Many of those skills and things were sort of indirectly transferred just by my being associated with my brother.

...we were paying only twenty dollars a month, that's all it took to go to school. But he sent me an extra twenty dollars, I remember the day, I think it was April 14. He said, "Here's an extra twenty dollars, it's spring. Enjoy it!"

Kutzbach: And you knew Paula at that time?

Suomi: Let's see, I don't think so. Well, so when I was in college, back in junior college too, one of those clubs was a photography club, naturally. So I learned how to develop pictures and things like that. So I had it as a hobby, and actually developed color pictures in the very early days before color pictures were common. If you go and buy some color film. So I got to be on the school annual, and I got to be the photography editor. I didn't have a camera, so I was wandering around the girls' gym one day and I saw a very nice camera there except it had some divisions on it that were in the way. So I blithely sawed them off and this became our camera.

Well, later on the gals' physical education teacher really gave me the dickens for stealing their camera. But I got very good pictures! And a very nice thing about this thing, on May 13, is that it is, I think, the 60th anniversary of the date that I proposed to Paula. So we had three previous dates, that was enough, and I proposed to her. And it was the wisest thing I ever did. So I'm going to try and work it into my talk, if I give a talk, saying, "My first proposal was 60 years ago,"

and then tell them what kind of proposal it was. And that it was accepted. I won't say I wrote the proposal, I'll just say I made the proposal. But anyway, that was...

So I had to catch up on some courses, and Paula had been told by her family that she didn't need the other courses, but she of course wanted to stay in school during the summer with me, so I graduated from college at the end of the summer. She got a job in Lakefield, Minnesota, as a schoolteacher, I got a job in New York Mills, Minnesota, but I had to teach junior high school. I was dying to teach chemistry and all the upper class courses, but somebody else had that job. So I left that and went to another town called Sleepy-Eyed, Minnesota: the sign said, "Protect 'Sleepy-Eyed' children." So somebody put the "-ed" on it. The American Legion used to have these signs everywhere. Much the same as those shaving signs [“Burma Shave”] that used to be on the road many years ago. You weren't here then, so you don't remember them.

So I taught school there and worked in a canning factory in the summertime. Then the following year I got a job at Fargo, Minnesota, which was a very nice place, a very nice school, and I enjoyed it very much. I had some very good students, some very good friends/associates, and then the war came along.

Kutzbach: Now that was only in let's say, 1936, or so that you were teaching school...

Suomi: I taught school for three years. And then, while we were not in the war, there were preparations for the war. Actually, it wasn't a war preparation at all, there was, as a matter of fact, the summer before we were married (we were married after that proposal, you see), which was August 10th. Then a course was offered by the Civilian Pilot Training Program where the Civil Aviation Authority (CAA at that time) allowed you to learn how to fly. And I was quite interested in flying, I figured I would have been an aviator, actually, or electrical engineer by interest, and so I took this course and passed it and flew in a little Piper Cub around on occasion, but we were married in the fall and then one year went by and then things got pretty active in that there were preparations for the war. The draft board was breathing down my neck and believe or not, I heard over the radio Professor Rossby from the University of Chicago, who talked about the need for meteorologists.

Kutzbach: Over the radio; amazing.

Suomi: And so, when I took these flying lessons, I had to take a course in aerology, it was called, or meteorology. So I learned about the adiabatic charts. And that thing was kind of neat, so--I was not interested in being a meteorologist, I was mainly interested in not getting in the infantry. And so I enrolled in the course at the University of Chicago.

Kutzbach: That was when?

Suomi: That was--well, we'll have to look that up. The point is that there were three groups in there. One group under Rossby was a Navy group, there were about six candidates. And they had it good. Their salary was about $250 a month. One was an Army group, to which Reid [Bryson?] belonged, and then there was a small group of twenty from the Civilian Pilot Training Program. Rossby was trying to have all these things full, and so--

Kutzbach: How did he do that, actually? You heard about it over the radio.

Suomi: _____ said, "Write to him." So I wrote to him.

Kutzbach: And he invited you for an interview?

Suomi: He said in the letter--I think I may have a copy of the letter around here...he said, "We're having trouble filling up this other slot. Would you mind changing from being an Air Force cadet to a Civilian Pilot Training Program cadet...?"--because I had the requirements for that. But we had $24 a month instead of $250! They called it a subsistence salary. It paid for our food, it paid for our books and all those things. So we didn't live high on the hog at all and I had to leave Paula, who was still in Fargo. But then I talked to Horace Byers, who was one of the professors and actually ended up being my thesis professor.

Kutzbach: You went to Chicago and then you talked with Horace Byers?

Suomi: So I was thinking of quitting the program because I was separated from Paula. So he said, "We'll see what we can do." He actually gave her a job. She was a map plotter. And she got to be in charge of all the map plotters. So she could plot a map and learn all the symbols better than I do. It was amazing.

Kutzbach: So you had been in Chicago for awhile by yourself. But you really did this because you didn't want to be in the infantry. You wanted to escape that, so it was better to be separated.

Suomi: I was quite disappointed that I didn't get into some radar work. I was really quite interested--I had heard about radar, although of course I didn't have any of the details for the simple reason that that was all secret, or for some electrical engineering job. But I got into meteorology by pure accident, pure accident.

Kutzbach: But you had an interest in the adiabatic--

Suomi: I had an interest in the adiabatic chart. My interest didn't extend very far, I just thought it was pretty neat. And that if meteorology was more like it, I wouldn't suffer too much. So, when I went to the University of Chicago, then--

Kutzbach: When you met Rossby for the first time, do you remember that?

Suomi: Not particularly, except that they always threw parties and we had a wonderful time and he was a wonderful teacher. You see, what he was able to do which most of the other professors were not able to do as effectively as he was able, and that is, he would present the problem verbally. Then he would present the problem graphically. And you could see the solution, graphically. Then he would present the problem mathematically. But the mathematics came LAST, not first. Very effective teaching. I remember his going pretty fast through a lecture and he had a piece of paper in his hand in which he seemd to be looking at. He just crumpled it up and threw it onto the table there, so after class I went up and grabbed it. All it said on there was, "Today, do not talk about turbulence." That's all! He was good at it.

There was another wonderful teacher there whose name was Michael Ference. He was a physicist by training. He was easily the very best teacher I ever had in my whole life. There was one other---one other was in Winona...

Kutzbach: Michael Ference was in Chicago?

Suomi: In Chicago.

Kutzbach: But you wanted to talk about someone in Winona.

Suomi: Winona, he was a chemist. And I came to them my first year away as a teacher, I came to the University of Wisconsin and studied a course in chemistry. I had this wonderful teacher, _____ Minet.

Kutzbach: How did you come to Wisconsin then?

Suomi: He graduated from Wisconsin, so I was interested in becoming a chemist as a result of Minet in college.

Kutzbach: Minet was from Winona, and he came from Wisconsin. And so he told you you should go--

Suomi: I don't know what he told me, I just found out that he went to Wisconsin, he was a darn good teacher, maybe they knew something about it here. I guess he suggested I go here. I don't recall that he pushed it, but he was a fabulous teacher also. He gave me a job as one of these jobs--NYA--National Youth Adminstration, where you would get some money by being his helper. So I took care of all the chemistry bottles and things like that. And during times when there wasn't too much money around, I would raid his brown sugar supply in his chemistry stockroom because eating some brown sugar really helped when you were hungry. So it was really touch-and-go. It came time for him to have some of that brown sugar for one of the experiments, and he didn't have any.

Kutzbach: You didn't know.

Suomi: I didn't know. So you can see that I did not have, certainly not a lucrative situation, I had a barely adequate situation.

Kutzbach: During college.

Suomi: And a scholarship that I got from John Blotnick, as a result of John Blotnick, if I weren't for that, there would simply be no chance for me.

Kutzbach: Now when you were in Wisconsin taking that chemistry course, do you remember who that was?

Suomi: We had two courses. One of them was on physical chemistry. I think the guy's name was Luten or Lumen; I had one of his books yet. And the other one was on the teaching of chemistry. I don't remember the guy's name, but he gave you a nice approach to teaching. I think that was fairly important.

Kutzbach: So you went there as a group or--

Suomi: I went there just by myself in the summer session. And it was hotter than blazes, other than that it was _____ during the summer.

Kutzbach: Did you like Madison then?

Suomi: Well, the first thing that hit me in Madison were these five-sided blocks. So the first week or so I was completely confused trying to go downtown because of the five-sided blocks. (Well, maybe it was the first two or three days). But I enjoyed Madison very much. And the lake was nice. It was just pleasant. Rooms were hot because there was no air conditioning and it happened to be a particularly hot summer. So I got through that, and went back then to a new job in Fargo. And in Fargo...

[At this point, the interview was continued on a new disk--"Suomi.2”].

Interview of Verner Suomi

TAPE 3, SIDE 1

Kutzbach: Today is May 14, 1994, and we are sitting together near the Capitol in Madison, Wisconsin. We are interviewing Vern Suomi on the day after of the celebration of the World Meteorological award that he was awarded yesterday. Bill Smith is here, Don Johnson, and Dave Johnson.

Johnson: I wanted to ask you--I've known you all my professional life, and of course my interests and my association with you have been largely in the weather satellite era. I've always been curious to know what got you interested in those early days of using satellites to observe the weather.

Suomi: I've thought about this question of why did I get interested. It wasn't in terms of the satellites themselves. My thesis was on the heat budget of a cornfield, and after I got through with it and got my degree, I said, "So what? It's a cornfield." A far more important question is the heat budget of the earth. So when the opportunity to be part of the IGY program on a satellite, it occurred to me that there was a very simple way to try to measure the heat budget of the earth. It wasn't the most accurate way in the world, but our knowledge of the albedo the earth, for example, was so poor; there were arguments about it--it should be 35% or 30% or less or more--so this was a very simple experiment that at least settled that it was near 30%.

So two things occurred: one of them is, what is the need (it's kind of fun to work on things that are needed). And the other is, what are the opportunities to meet that need. Is the new gadget or the new truck or the new satellite or the new thermometer in position to meet that need? So, we are really talking about two things: a platform to carry it where it ought to be, and the gadget itself, which should measure what you want it to measure. I'm reminded of Ed Lorenz at a Woods Hole conference. He got up to give his little talk on weather or predictability or something. He said, "I have three questions." And he wrote them on the board. The first one was, "What do we want to predict?" The second question was, "What are we able to predict?" And the third question was, "Is there anything common between 1 and 2?" That seemed to boil those down to the basic question. I sort of said, "Can we do it on this gadget? Does the gadget do what we want it to do?" So, you see that I really never think of a brand-new thing. I think of how can I attach to something that's going to be going anyway. And that's maybe because I'm too lazy to think of a brand-new thing. That's it.

Johnson: But you were thinking about this even before Sputnik was launched. I'm curious to know as to what associations you had that got you thinking in this direction.

Suomi: Well, I think it was the need to look at these things on a larger scale, rather than an individual cornfield. And, Harry Wexler brought these points up. He had beautiful diagrams of the imagined cloud structure and of course there were some photographs of, I think, from rockets that illustrated the opportunities, too.

So again, it was my "How can I use this thing to do what I want to do," rather than, designing the rocket and all that stuff in order to do it. So basically--

Johnson: Vern, how did you come to be selected for a ride? There weren't very many.

Suomi: We can credit that with Harry Wexler. Harry Wexler was the chairman of the meteorological aspect of the IGY, and the way it all started was, Joe Kaplan came to the University of Wisconsin to describe the IGY program. And in it, he talked about their satellite program, which was part of the IGY. So after the program, or maybe even before the program, I went down and talked to him in the auditorium, and said, "I've got an experiment that we could put on this simple spacecraft." I described it very briefly. He said, "Why don't you get in touch with Harry Wexler?", who was chairman of the meteorological aspect of the IGY. And the date of entry had actually passed by a few days. And I talked to Harry Wexler and [he] opened the door again and snuck me in. So it was pretty close.

The other meteorological satellite was that by Bill Strouth, which he had in essence a photometer which was supposed to scan the earth as the spacecraft was spinning. Much the same as a spin-scan camera for the geostationary satellites of the day. So there was a contest between which one it should be. We weren't going to have both. However, then, Sputnik came along and the program exploded so that it was their intent then to fly both.

Well, mine went in the drink and Bill Strouth's went up, but unfortunately, Bill Strouth's tumbled because he did not balance between the axis of maximum angular momentum and his _____ spin axes were not exactly matched. There may have been other complications, too.

Interestingly enough, in the early ones which were flown on the Jupiter, Jim Van Allen had a long cigar-shaped spacecraft, too, with flexible antennas. And the first thing they had learned, that after it flew, was that it tumbled like a fan. So if anyone had equipped that particular spacecraft with a photometer sticking out the front end or the back end, they would have gotten a very nice gadget. Because it had a natural spin, and the axis was well-defined when you have a long object, the axis of maximum angular momentum is normal to the axis of the device and so on. It would have worked fine. I had thought about proposing another one, using that concept exactly, but never got around to it.

I don't know if I've answered your question.

Johnson: It always takes key individuals to make it happen and I think you did.

You pursued the radiation budget after Explorer 7 and that had instruments flying on the Tyros and _____ Series. What motivated you to keep plugging and improving these measurements...?

Suomi: Those were easy. The original Explorer 7 was in a highly elliptical orbit, something like 1500 nautical miles on one apogee, then maybe a little over 200 miles on perigee. So that the angle that this simple hemisphere saw--which was earth--was widely changing, so then, it seems like Tyros came along, which was a rather nice, circular orbit, which had made calculations so much easier. And it didn't require a wide-bandwidth or anything like that, so it seemed sensible to that distance. And we actually put it on the Air Force one too. So we had these gadgets on both. Tom Landrahar worked on the data; actually that was his thesis...

The thing that showed up was that the albedo was not at 35, but was on the order of 29, maybe 30. Basic accuracy of our system was not that high. For example, it did not know the absolute value of the radiation from the sun. I mean that, that would act as a calibrator for the whole thing, and we could have been much more precise. But it was simple; there were three places on earth that were different. One of them was on the dark side of the earth you have only long-wave radiation and on the sunny side of the earth, you have long-wave radiation, you have reflective radiation, and you have the sun shining on the device. And then there is part of the orbit which is beyond the sunset point, which is in darkness as far as the sun is concerned. But the sensor, or satellite, is still up in the sunlit portion of the orbit. So you had the sun and the earth radiation all by itself. Then, another case where you had the sun, earth radiation and the reflective radiation all by itself. In another place there was only earth radiation. And heavens, that's three unknowns, and three equations and there was nothing to solve it...

Johnson: I was going to say, I think the data processing, the way you were able to calibrate the data without the kinds of standards that we fly in space today is certainly genius, as well as the instruments that were put up there.

Suomi: All we did was to measure the temperature of the little sphere, or hemisphere, it was actually a hemisphere, because we were not allowed to expose the sphere a long stick. But a hemisphere against a mirror looks like a sphere, so it acted like a sphere.

Johnson #2: You were the first and last chief scientist for the Weather Bureau back in 1964. What are your fondest memories or any memories, particularly getting the spin-scan camera on ATS---

Suomi: As a--I don't know if I mentioned this yesterday, but I certainly intended to. I had a pretty confused talk, as I recall yesterday. But when I was Chief Scientist of the

Weather Bureau...I had very good access to Bob White. And I already thought about the possibility of measuring the clouds on the earth from a geostationery satellite. Before I came here, I made some experiments at home and proved that it would work. You see, this is not the heat budget now, this is the spin-scan camera. Completely different. It's not on a low satellite, it's on a geostationery satellite. And so, I remember very distinctly being led by Wise up in Bethesda in a Chinese restaurant, and we had dinner together and then he said, "Why don't we beat the Russians on this one?" That started it, and of course, he made close contact with Homer Newell, who was in a similar position, but in NASA. And if I hadn't been in Washington to talk to him often and explain what we were trying to do, I don't think it would have come to pass. In addition to that, being in Washington, somebody from Hughes or Santa Barbara Research, came to talk to me about it too, and as I indicated yesterday, Roger Thompson was the one who built the first camera, which was very simple, and they wouldn't have even have built that if it weren't for Dave Johnson, who took some of the money we had in advance from him and allowed it to be transferred so that this camera was built. And I recall the cost of the whole thing was $75,000.

Johnson: Amazing.

Suomi: So, Dave, you deserve a lot of credit on this, too. You made it possible.

Johnson: The idea of flying that experiment on a communications satellite, that was unique at that time.

Suomi: That happened rather neatly. There was an article in **Electronics**, and I looked at the back issues of **Electronics** to see if I could find that article. I didn't look very carefully, but I think Gene Phillips _____. There was a two-page article, just two pages which described the ATS-1. And it occurred to me that, heavens, this thing is spinning. It's going to be solid as a rock and weighs half a ton. It's six feet high and maybe that diameter, and you could put a simple photometer sticking out the side, and if you could move that thing, the image up or down, or the pinhole up and down by a number of means--moving the mirror, moving the camera, even moving the aperture--that you could scan the earth. So Roger Thompson and Bill Exner out there, we built a simulated thing. The camera wasn't spinning, but we had a mirror in front of the camera which was spinning like the satellite would be spinning, and we took a picture of the Santa Barbara Hills. They were very clear; the Santa Barbara Hills were 15-20 miles away; they were a long distance away. And they came out very, very nice, except when someone was walking on the roof and jiggled the whole thing. I think it was that picture, which when shown to Bob White and to Homer Newell, convinced them, "yeah, this thing is going to work." And all the rest of the gobbledy-gook and talk about why it should work was beside the point in comparison to that picture. Which says, that a picture is worth a thousand words, but in this case, maybe it was worth ten thousand words.

Johnson: Speaking of pictures, I'll never forget, I was here at the time, seeing the first color images from ATS-3, the 3-color camera. Yet you didn't seem to get too excited about that. Your emphasis was always on the quantitative applications of the data, not producing pretty pictures.

Suomi: Well, I think I was educated on that, I can't remember whether this occurrred first, or afterwards. I think it occurred first. It was between the black-and-white pictures and the ATS-3, which gave the color pictures. I was part of a discussion, the preliminary discussion maybe even, about GARP. There was a meeting held at Goddard with the people who were producing pictures from TIROS and from Mini-TIROS. Or from NIMBUS. I can't remember if NIMBUS flew _____ at that time. And Jule Charney was there, too. Bill Nornberg and Bill Strouth and the rest of the _____ crew were rather insistent that this was valuable information, and that the _____ should be able to use it. And Jule Charney said, "I don't know how to stuff a picture into a model." So it got to be a pretty lively discussion, practically to fisticuffs. And so I had always been interested therefore in getting numbers out of the images, rather than just beautiful images. The numbers can be from a wide range of things: they can be the temperature, or they can be the brightness or they can be the shape or they can be the wavelengths of the film. But it is possible to get numbers from these pictures and the modelers can use the numbers. In the case of two pictures from a geostationery satellite, you can take the difference in the position of the clouds in the two pictures and presumably the wind is responsible for moving those clouds. Not always. You can have waves. You can have an orographic cloud that doesn't move at all while the wind is blowing through it, so this isn't going to be all that easy all the time, but by and large, one can do quite well. The big difficulty is that you didn't know the heights of the clouds, except from some notion of its temperature if it were a thick enough cloud, so you could make a good guess on _____.

The really sad thing, and I think it's sad to this day, is that we have missed the opportunity to make use [of] in the overlap region the stereo photograph, the pictures of the cloud from two different satellites at the same time. Then we did the heights, and the heights can be measured quite well to about 500 meters. Bill Bryson got his degree in electrical engineering studying this aspect of image analysis. So if all three geostationary satellites, except the two United States ones, had slightly different scan rates, more or less all of them had the same period and the spin of 100 rpm. But one would scan in 25 minutes, one would scan in 20 minutes, another scan in 18 or so. We couldn't get an exact match. However, there were portions of the picture--what was even worse was the United States scanned these pictures from north to south, and the Europeans scanned them from south to north. You can't get any kind of _____

So, as I mentioned, I went to Europe and tried to convince them to change the scan, so that we could get stereo pictures and get the cloud heights. Because then

the value of the cloud drift winds would be completely _____ because this is the source of the largest error.

I didn't get very far; all I got was a necktie out of that deal. This _____ with ESA, European Space Agency--I don't know if they were ashamed of it or what, but it wasn't very _____

While Dave is dreaming here that I think he was in charge at that time of the U.S. satellite program. I didn't get any further with him. Here we have two spacecraft and one would scan on the hour or the other on the half hour. The second spacecraft would scan on the fifteen minutes or quarter hour and on the three-quarters of an hour. Now the world won't end if we were to scan together, but that never came to pass.

Johnson: Ground station, ground system processing was the problem. If we ever get some money...

Suomi: Another antenna for the benefits that would have come from it would have been a bargain.

Johnson: You're always thirty years ahead of your time. Maybe it will happen now, the new spacecrafts seem more flexible, synchronized with other spacecraft.

?: Somebody ought to try it at least.

Johnson: If I remember yesterday, though, I think you said, someone said that the original geosynchronous experiment was for measuring winds, but in many ways, the visual imageries had the real impact on operational meteorology.

Suomi: That's a tough one. I think, as I mentioned very briefly and probably nobody got the point because it was so brief, there are two parts of the communication aspect. One of them is that you can show the clouds to the forecasters, and if you can get numbers out of it, you can help the forecasters even more. That's one communication.

But the other communication is to the public, and it is very difficult to tell where a hurricane is going to go exactly from even a movie of the hurricane. It wiggles around and sometimes goes in loops. So just having a series of images of the hurricane tells you what direction it's moving in general. But apart from that...in order to be very useful, one has to predict the landfall, which was on the order of tens of miles, or maybe twenties of miles, in order that people out of range of the hurricane don't end up spending all that money to board up their place and so on. We don't have that ability now. Maybe using this spacecraft to get something about the wind velocity field or the temperature field surrounding the hurricane could improve on that. I think you have worked yourself on that, Bill; at least you've convinced me where you showed the temperature field quite well. Now, I

don't know why the hurricane people never used it, but it seems to me what you showed me was pretty dramatic.

On the other hand, as I mentioned in my talk yesterday, when the public can see the storm--that is, approaching their general area, then they have a greater tendency to get the hell out of the way. That's how the lines have been _____; this is because of the effective communication. One of the sad things--well, not even sad, but _____--is I don't know the names of the people whose lives I've saved because of _____. When I got to my surgeon who operates on my ticker and all the other tickers that's he operated on, he has the names of the people he's saved. And I think that would be somewhat more rewarding. So I think it's conceivable that one could argue that I've saved more lives or the satellite has saved more lives than a single cardiologist could save in a year, although he can do quite well. But I don't know their names.

Johnson: Well, I think it's important to pose that question in a different way than just simply say, "What would happen if you were to take away that visual image to the public, to the weather forecaster?" Now he comes to depend upon it.

Suomi: I think a great deal would happen. You'd lose a lot of lives. In our last hurricane, Andrew, I don't know, the number of lives lost was less than 50. Whereas in the old days, one they named Hugo, the lives lost was in hundreds and in some hurricanes, the ones off Texas in the early days, thousands lost their lives. So seeing the pictures so that you get an appreciation of what's out there as well as getting some information that tells you WHERE it is--that's equally important. Although you can't trust the derivative of where it's going to go. But knowing where it is is a pretty valuable clue.

And so if we didn't have that, it would be--we do have radar, but the horizon of radar is not so far. And of course, one can fly airplanes into the middle of itand tell where it is, and then of course mention the winds, too. But even here, it isn't necessarily--even with aircraft winds, or aircraft measurements, I don't think you can predict where it's going to go exactly, unless you have the surrounding fields to determine where the hurricane is going to go. We have not reached that capability.

On the other hand, if we get this application business that I mentioned briefly at the end of my talk full up so that we have many observations rather than just a few, then we have a very good description of the structure of the atmosphere. Even in the tropics it's conceivable that one could begin to predict the path of the hurricane much better.

Johnson: Well, Vern, you pioneered this idea of putting the picture together with the data in the computer, but it is now a tool that is used worldwide--

Suomi: The history of that is kind of interesting. You see the first two satellites, ATS-1 and ATS-3, were very simple devices where we took the output from the photomultiplier to--and sent the analog signal back, not a digital signal, but an analog back. One way to put that together was to use photographic means of _____; scan on an oscillioscope to--which got brighter and dimmer much the same as a television _____ and then move the scan lines on the television tube to correspond to the tipping of the telescope and then you could, in twenty minutes time or so, generate a picture.

Another one that I played with and others did too is basically a facsimile recorder. The spacecraft was spinning around at 100 rpm and the scan across the earth was only 30 milliseconds, roughly the same time that it takes the whole picture on television to occur. Not one scan line, but the whole picture. And so if I had my proximity recorder spinning twenty times as fast as the spacecraft, since the area on the earth was only 1/20 of the total scan, looking at the stars and everything else, then you could create a picture. But I think the thing that really did it for me was Ted Fujita. Ted Fujita had a wonderful photo lab down there in Chicago, and he is a fabulous photographer, knows how to combine things and put grids on and all that. He made a movie of ATS-3; he simply beat the pants off me with my own satellite! I didn't like that. And then, Bill Exner showed me a gadget that he had in which he got the picture on a television screen by having a long shift register, and he would digitize an analog signal and store it on this long shift register, or "FIFOM"--'First in, first out memory.' And he would simply squirt that onto the television screen because you could start the timing at the right point, and so on. So we had two--or had images on the television screen. But he then made measurements on the television screen much as the same as the people in _____, Ted Fujita and the rest of them were making measurements of the images on photographs, measure the distance and so on. Well, I thought that was crazy. Once you got it digitized, do it in a computer, and the person that steps outside of the channel of information flow, he guides it, but he doesn't participate in it where, when you make the measurements by hand, you're in the channel--you represent an enormous slow-up of the procedure. So once you get in the computer, then it becomes much easier to handle. That's the real basis of MACIDAS (?) and MACIDAS is not the name of the Scotchman who invented this at all--it simply means "Man Computer Interactive Data Processing System"--"Access System." And so, that was the driving force, but it was seeing how it was possible to put this together. Then, of course, I saw instant replay of football and that would be kind of nice to have instant replay of the weather. So we modified and Rick, my son, played a very important role in this. We modified it so one could put one line at a time via the computer and create that image. Then, you could play the images back in sequence and see the motion. It was as simple as that. The speed of our photography was one picture in twenty minutes. Whereas the speed of television is thirty complete pictures in one second. And so the speed of response was very very different. At the same time, when you take the advanced GOES satellite and instead of it having 2,000 lines like the original spin-scan camera, it has 16,000 lines. That is quite a bit more than 500 lines

which you have in an ordinary television set, and so the quality is very high. Actually it amounts to about--if you were sitting on the geostationary satellite, and the 8th power binoculars and you were looking at the earth, that's about the resolution. It's not too much.

The thing that occurred to me just a couple of days ago when I was trying to say, what am I going to talk about, and I was hoping to have something that I could flash and just go round and round, and say, "The only part that counts is maybe that _____ part over there, the rest of it's the stars and the moon and the sun. The pencil beam developed by this telescopic photometer is a very skinny pencil beam that is 1 kilometer in diameter and 33,000 kilometers long. That's a skinny pencil.

Now the flaw in all of this, people thought about these images as television images and in an ordinary television image, you have only about 5 or 6, maybe 7 bits, which is maybe 128 levels or less. Now on the cloud pictures, the range of variation is much higher in that if you're looking only at the earth, wow--you're looking at a pretty dark target. If you're looking only at clouds, you're looking at a great target. Whereas ordinary television is considered, you're looking at something light and something dark. So by improving the dynamic range to what we had on the present satellite, 12 digit or 10 digit, you have quite a bit more than even the dynamic range is so great. Therefore you can stretch the contrast for different parts of the picture, and you can see much, much more. So the pictures look better, like they have higher resolution when the resolution is equal, but it has a wonderful dynamic range, you won't see any scan lines, nothing. So it was a big improvement.

Johnson: This tool, MACIDAS, that you developed for analyzing satellite images of course is used for analyzing and displaying and even presenting all meteorological data before it gets--did you ever envision at the time that it would have such an enormous impact--?

Suomi: Well, it wasn't too much of a stretch of the imagination. But if you have it in the computer, and capable people who know how to program, they can do all these things. They can change the format of the map and _____. You can make a squiggled earth or elliptical earth, round. Once you have it in the computer, you can do many many things, adding additional information be taken from the surface or taken from the sky, it doesn't make too much difference. The key is the flexibility imposed by the computer. When we first started, the only computer which was adequate to the task was probably a mainframe, not a very elegant mainframe, but it had to be considered as a mainframe. Whereas now with personal computers developing the way they're developing, it's no longer necessary to have the mainframe. You can use a small computer. The mainframe acts more like a library; it works to store the data. You know more about that, Bill, than I do...you should be talking, not me.

Johnson: I'm interested; I know some of the individuals, of course, in the MACIDAS development--Eric Smith, for example. Who do you credit with extending its applications to non-satellite data, conventional weather data and so on...?

Suomi: I think--I don't have that clearly in mind because it was, still is, a more or less team effort. What I do have clearly in mind is that early pioneers, Eric Smith and Dennis Phillips and John Denson--John Denson was the person who manipulated the mainframe so it acted the way we wanted it to act. And he still is doing that.

Eric Smith--well, I should first talk about Dennis Phillips--because he brought the skill of navigation, so we know where we are on earth. Those kinds of programs. Eric Smith used correlation between one picture and the next picture, and from that you could get a fairly accurate measurement of the displacement. And so, he's responsible for the LIMS. They didn't have much of a computer to work on at that time. It was a Raytheon 440, and that was a pretty simple computer which used not silicon transistors, but _____ the name slips from me, it was so long ago...

Johnson: On the meteorological part, I think Tom Whitaker and Ralph Niedecker.

Suomi: Oh, yes, Tom Whitaker and Ralph Niedecker were in on that, absolutely. The point is, the whole group could get in on different aspects of it because you had this basic data set of vantage, but in digital form as opposed to analog form. Of course, you could stretch the contrast or you could subtract. One could, for example, take one wavelength and subtract it from another wavelength and the difference could be displayed. In many instances, this is pretty powerful. Inouye in Japan did that by taking the difference between the infrared at the lower red of the IR window and the upper end of the IR window, and found that the difference gave one some information about the probability of rain. Only a few weeks ago, maybe a month ago, Steve Ackerman has taken the difference between a 6.7 micron water vapor band and the longer infrared band around 12 microns or so. This is a simple switch that when one--when the difference is positive, it means one thing, and when the difference is negative, it means another thing with some exceptions. And he can tell where it's raining. Very nice, very simple.

The dataset...has many infrared channels, and I said, this value is going to be greater not so much in terms of trying to provide better soundings but certainly in the subtle differences of image structure, that you get at different wavelengths. And they give you differences in sums and this information in combination. I think _____ about what's out there.

You should be talking about this, Bill, not me. You know more about it than I do.

Johnson: I would like to ask a question since all three of you are here, and it hasn't been brought up. Rumor has it that between you, Verner, and Dave, that you agreed to send this _____ up to Wisconsin. Have you got a comment on that?

Suomi: I've got a comment on that. That is another example of the government at its best. Dave and I got to know each other very well because of the fact that I was in Washington for awhile and we've been very dear friends for many years. So, I don't know who suggested it--he may have suggested it--but he took eight of his people from his lab and sent them to Madison. Now, these individuals sold his houses and moved north to Madison on nothing but an agreement between Dave and myself. If one of us died, they were in trouble. Because there was no agreement. So, after a few years, it occurred to me...that maybe we ought to formalize this and at least have a document that these people can rest their careers on because they made a very big sacrifice in terms of their personal lives. They may have improved their personal lives--you get that impression in talking to them--but what they are able to do professionally has been fantastic. They've been in on all of this in the link between what you find, Bill, and what others find, and sneaking it in through the operational aspects of the satellite. This is not a trivial contribution. My only disappointment is that maybe the people in Washington don't appreciate how good these guys are. They're very good.

Johnson: Are you sure you didn't put words in Dave's mouth? I would presume that he would have been a little disappointed to lose some of his key people.

Suomi: I think we have to give Dave the credit for the initiative. I wasn't hanging around his neck saying, "Send me these eight people." He was the _____ what we were doing up there, and presumably thought his people would benefit if they were up there. You have to remember that part of Dave's job was to get the satellite data out fast enough so that the forecasters could use it. And for many years, even after MACIDAS...was making movies photographically of the clouds and getting the drift of the upper clouds at least by making measurements on a great big screen, by hand. Similarly, he had another person (his name slips me)--

Johnson: Vince Oliver.

Suomi: Vince Oliver was showing possibility, but Larry, not Larry Hecock--he was a computer guy and he measured the low-level winds in the computer.

Johnson: Was it Charlie Brewster?

Suomi: No. He went _____ after awhile. Well, anyway, the thing is, Dave had to get these things out in time so that the forecasters could use them. Whereas the people in the group that came to Madison were basically researchers, what could you do with this data? And then once they found what one could do, then they speeded up so it could be used for operational as, I've already mentioned, a person in operational meteorology, it was more important to get the forecasts out on time than it is to have it right.

Johnson: Was it John Liese?

Suomi: John Liese was the other guy, but I talked to--I've got a mental bloc on him...

Johnson: If I remember right though, the fact that we had MACIDAS here as a resource in dealing with much of the data and development of things for research was a factor--

Johnson: If I could just comment on that a little bit, at that time, there was the NAS program, which Verner started and three groups were very interested in developing the processing capability for the NAS instrument. One was at Goddard, one was here at the University, and my group in Washington was involved in that and we were very impressed with what was going on here with the MACIDAS system, and its applications to the NAS, and I think that's what started the motivation for combining efforts.

Suomi: That was a very important move, very important.

Johnson: In fact, it's been modeled by other governments as a result of our instititute--the British Met Office established a similar institute with Oxford University, John _____

Suomi: There was this agreement between Dave and myself. I don't think _____ in any form.

Johnson: I think we exchanged letters...not very much until we got the formal agreement. That's been expanded up to Colorado State University, for example. In many ways, the cooperative agreement that NOAA has these days to remodel the--

Johnson: Even the Weather Service modernization program, where they're co-locating their regional offices with universities was influenced by the success of this--

Suomi: Worked like a dream. The one thing that's maybe wrong is that they've not been indentified as an entity of their own by the Weather Service or by us for that matter. The degree of recognition they deserve. I'm going to try to do something about that.

Johnson: Vern, it certainly was the NAS program in part that brought the federal people to work with your scientists, and what they got amazed me in the _____ , your _____ concept is that you proposed to put this sounder on a geostationary satellite even before the first one was ever demonstrated, and I remember people in Washington, engineers say that this was a very, very difficult thing to do, you're so far away from the earth that you're not going to get the signal-to-noise and so on, but you persevered and succeeded, actually.

Suomi: Actually, it was very simple, just look at the same place for the number of spins, and the signal does come up, then you're all right. You got to look at the whole earth that way--

END OF TAPE 3, SIDE 1

Interview of Verner Suomi

TAPE 3, SIDE 2

Johnson: Do any subjects remain or [are there] items to discuss now in the last 45 minutes? You said there's one thing--

Suomi: There is one item that deserves mention. I think it was [garbled due to static on tape]. _____ it was time to try and put something together, so I was assigned to "go to my room and not to come out until it was done." And Dave Johnson was at the door practically to prevent my getting out. So we spent the…

{Interview not transcribed after this point because of severestatic on tape.)