ORAL HISTORY TRANSCRIPT

HAROLD B. FINGER
INTERVIEWED BY KEVIN M. RUSNAK
CHEVY CHASE, MARYLAND – 16 MAY 2002

RUSNAK: Today is May 16, 2002. This interview with Harry Finger is being conducted in his home in Chevy Chase, Maryland, for the NASA Oral History Project. The interviewer is Kevin Rusnak.

Thank you for inviting me into your home this morning to spend a few hours with you.

FINGER: Well, it's good to be with you, let me tell you. I'm pleased to be able to talk about some of these subjects.

RUSNAK: Well, great. Well, if we can start off with, as I suggested, some of your background that brought you into the NACA, your education, that sort of thing.

FINGER: Okay. I was born and raised in New York City [New York]. Born in Brooklyn, then moved to the Bronx. In fact, my family, though I can't remember any of it because I was just a tot, lived on Kelly Street, which is where [current Secretary of State] Colin [L.] Powell later was raised. So it was a mixed kind of community.

Then we moved further up into the Bronx, and I went to grade school, and then got into an advanced school, the Townsend-Harris High School, which was kind of a prep school for the City College of New York. I graduated from there in 1940. I was born in '24, so I was sixteen when I graduated from high school.

One interesting thing is, I rode by subway downtown to where one of the City College schools is on 23rd Street, by myself, without any trouble or fear. My parents weren't worried about it or anything.

Then I went to City College and went into the engineering school, School of Engineering, and got my bachelor's in mechanical engineering in '44, May of '44.

We were at war at that time, and before I actually graduated, in anticipation of graduation, … I had a deferral till I graduated—I applied for a commission in the Navy, and went through several discussions, hearings, and some tests, … and went to my last one, and, in my mind, there was no question I was going to be an ensign in the Navy.

I had also applied to the NACA [National Advisory Committee for Aeronautics], and when I came home for my last [Navy] interview, there was a telegram there offering me a job at the Aircraft [Engine] Research [Laboratory] in Cleveland [Ohio]. That's not the right name; I'll look it up. The Aircraft Engine Research [Laboratory], I think, in Cleveland. It was something like that. I would be then put into the Air Corps enlisted reserve with basically no active duty, and I decided to take that.

So in May of '44, I started working in Cleveland. The first thing I did there—well, I was just a young punk, learning, basically, twenty—I was … involved in testing German and Japanese superchargers for their engines so we'd get a good feel for what they were doing. But that led very quickly to testing [compressors] for jet engines, basically, gas turbine engines.

NACA itself, Gene [Eugene] Wasielewski and others, … [Eastman Jacobs] and so on, had done work on developing an axial flow compressor, a eight-stage axial flow compressor, which was really very advanced, and we did work on that. So I got heavily involved into compressor research with that. In fact, I found a picture that I can show you that indicates some of that range of work, kind of an old picture where it indicates me giving a talk. This was in '49. This is the axial flow compressor, and I was making a presentation.

But one of the things we talked about was how do you get broader range to [of compressor] operation so you can go to supersonic speeds with that, and so on, and we removed the inlet guide vanes and ran the compressor at higher Mach numbers. And it turned out that that actually gave us greater range. And I was involved in that, and my position increased. I started off as just [a Mechanical Engineer and then became] an Aeronautic[al] Research Scientist in NACA, and then kept moving up—

[Telephone rings. Tape recorder turned off.]

FINGER: But this picture does indicate the full range of compressor and turbine research that we were involved in, and I was in the Compressor and Turbine Research Division. And in ['47] it was [renamed] Lewis Lab [Lewis Flight Propulsion Research Laboratory], named after George W. Lewis.

RUSNAK: By the end of World War II, there was some consternation expressed over the fact that the U.S. had kind of lagged behind in jet engine research. Did you find then that that was the field that was receiving a lot of emphasis because of that?

FINGER: Well, there's no question that the British, with the [Frank] Whittle engine, turned out the first—it was a centrifugal compressor system. And we did tests on what was called an I-16, and I-40, as I recall, R-16, I think we called it, somehow. But we moved to axial flow, which has become, of course, the mainstay of jet engines. So we advanced things at that time. I don't think we had that feeling, because we also tested those big centrifugal compressors with dual entry and all of that. I've probably got some pictures showing some of the test facilities, and there's no question Lewis had outstanding propulsion test facilities.

I might just mention, one of the areas that concerns many of us now, and, in fact, the NASA Alumni League is working with other organizations in a coalition, is our concern that

we're not doing enough in aeronautics advancement today. As a result, the U.S. market share in the world is decreasing while the European and other countries' market share is increasing, partly because of government support for their companies, whereas in the U.S. we have in NASA trivial aeronautics work. It's all listed under "aerospace" as if they were all the same. Well, they're not. And there are now some hearings related to that, and there's a commission that's been set up to look at the aerospace industry capability and needs and so on. They, in fact, had a hearing yesterday.

So, anyway, I did move up in NASA, worked with some outstanding people, and a very large number of the people that I went to school with at City College went out to Cleveland. I've got another picture that I have to make copies of to get to some of my past friends—well, two. Here's a picture of just a batch of us walking along. All of those people came from City College of New York and worked in Cleveland.

RUSNAK: This is in Cleveland?

FINGER: Yes, that was in Cleveland. And this was in the office I had—this is one of the fellows that also came from City College—in the Compressor [and] Turbine Division. All of these went to different places. So there was a great movement into that area. No question about it.

So that's where I spent a good bit of time, and really learned a lot. I keep saying there was a real encouragement for young people to participate with the very heads of the agency all the way through, with open discussion, with the ability to sit and listen, but also to raise questions, and it's something that was just built into me throughout my career, to encourage that for other people, but also to use that opportunity myself. And I learned tremendously from that.

RUSNAK: NACA was somewhat famous for having a very rigorous methodology in terms of putting out reports and the research they did. What experience did you have with that?

FINGER: Oh, I was involved as the sole author, or one of several authors, on a whole range of reports, the big bulk of them classified, now unclassified. I've still got several of them now that are unclassified on various of the subjects that we tested. All of that material was reported.

Although it's not related to that early work in any way, when we get to it, talking nuclear propulsion, I'll give you some of the background of a meeting I was at in Russia with a man who headed one of the Russian institutes on nuclear propulsion. In this great big conference room—I didn't even know if he knew who I was—he turned to me and he said, "Mr. Finger, we knew what you were doing. No one gave us your reports, but we knew what you were doing." [Laughs] And I'll tell you more about that later.

But there's no question, all of it was reported, some of it in unclassified form. There were many open talks about it, but a big batch of it was classified.

RUSNAK: What attention from industry did your work particularly receive?

FINGER: Oh, quite a bit. There were quite a few companies who were involved. I think Pratt & Whitney, General Electric, a whole host of engine companies. I was involved in the engine side of it more than anything else, so it was the engine companies—Allison was one of the companies at that time that was involved. We would do testing on various components of these compressors to determine how each really performed, and then how the whole system would perform in an actual engine.

One of the things that happens is a compressor has a certain range of operation, and beyond that, if the angles of attack on the blades become too wide, you get into a stall of those blades. The result of that is a surge, unstable operation of the compressor, leading to unstable operation of the whole engine, turbojet engine. The idea was to try to extend that operating

range as much as possible. That's the work we did which led to a transonic compressor concept, which is now openly discussed.

In fact, interestingly, I found a poster, which I have someplace here, just a few weeks ago about the Air Force Research Lab [Wright-Patterson Air Force Base, Dayton, Ohio], a poster on the wall in an exhibit they had at the AIAA [American Institute of Aeronautics and Astronautics] meeting here in Crystal City [Virginia] a month ago, which talked about multistage transonic compressor operation. And I thought, "Wait a minute. I was working on that forty years ago." Or fifty years ago. They took the poster down and gave it to me. [Laughter]

But we were way ahead, and actually jet engines were substantially affected. So we tested engine components in these systems, but also doing it in a way with comprehensive instrumentation and so on, through airflow propulsion facilities where we could actually suggest what the performance would be and how to improve it. And that's what we did.

RUSNAK: Earlier you had mentioned some of the differences between the British and the Americans. What exposure did you have to what was going on in other countries and of what utility did you find that information?

FINGER: I'll tell you, I can't say that I really had a lot of link to the other countries. It was later that I got into that, but it was not really in the aircraft side. It was later when we got into more of the space activities in NASA.

Actually, we got to a point in Cleveland—and this is sort of a little vignette I can tell you about—and, again, it relates to the fact that everyone was really encouraged to work as a unit, to work with your bosses, your leaders, and everything. I had an outstanding division chief, and I worked in a group that had tremendous leaders. My division chief was a guy by the name of Oscar W. Schey, S-C-H-E-Y. Outstanding. I learned so much from him. Then there was a Bob [Robert O.] Bullock and a Bob [Robert E.] English, and [Howard Buckner], I don't know, all

kinds of people in the Compressor and Turbine Division. We were encouraged, really, to talk about whatever we felt.

One time, at a picnic, after I had been involved in the compressor and turbine research quite a bit—I got into turbine work also, air flow conditions in turbines—at a picnic one time, Abe Silverstein and his wife were there, and he was—I don't know if he was head of the lab. I think he was head of the lab at that time, after Ray [Edward Raymond] Sharp left. Or Ray Sharp—Edward Sharp—may still have been director. I'm not absolutely sure. But I think Abe may have been a deputy or something like that, and I'd have to check that. [I believe he was still Chief of Research at that time.] It was still NACA. Standing and talking to Abe, I said, "You know, Abe, I think we've made about as much gain as we're going to make on these axial flow compressors and turbines. I'm ready for something new."

And he said, "Well, I'm thinking about something, and if I move ahead with it, I'll get in touch with you." It was not very long, maybe just a few days, maybe a week, he called me to his office, and he said, "I'm thinking of setting up a nuclear training school." And he pulled together a group of people from diverse organizations, quite a few from the Compressor and Turbine Division—Bob English, Eldon Hall, a bunch of others, and myself. There were about twenty, I think. Incidentally, I think that's written up in a book already, that point, and I can refer that to you in a moment. [Engines and Innovation by Virginia Dawson. P. 156—NASA History Series.]

We spent all our time in class. I'd go up to the attic at night to do work on it, homework, and so on. A guy by the name of Jim Blue—the Nuclear Division people were the ones who really taught us. It was the Nuclear Division in NACA at that time. I guess we spent over a year at that. I can't tell you the exact time.

Then, after that, I became head of a shielding group and also a group to look at nuclear propulsion, so that led me into the nuclear field. [Other than 6 months in school] I didn't have

formal training, but my point is, it came out of the ability to just talk to the boss, you might say, without any concern.

I can give you another vignette that's kind of interesting because things got personal, too. I mentioned Oscar Schey. I didn't have a car, and there was an outfit that came to Cleveland that was going to sell cars at the cheap, you might say. They went out and got all kinds of orders, and I didn't have any money, so I went to Oscar Schey, I said, "Can you loan me money to make a deposit?" And he did. Then the word came around that they were a phony outfit, so, fortunately, I went back and collected my deposit and paid him back. But it's that kind of—the relationship was there that way. And I maintained a contact with him till he died, long after he left NACA, long after it became NASA. He was just an outstanding person.

I've maintained contact with all those people that I could. In fact, we have reunions every two, three years. [In 2003] there's another one supposed to come up in Cleveland next year, of NACA.

RUSNAK: Do you think that kind of attitude was peculiar to your area or was that kind of—

FINGER: No, it was across the board. The whole organization was encouraged that way. The leadership in each of the organizations, first of all, they had all worked together. A big chunk was started at Langley Field [now Langley Research Center], Virginia, and that's where things grew. Out of that came the Ames [now Ames Research Center, Mountain View, California] lab. Out of that, you might say, came the Cleveland lab because they all [started there]—NACA Langley goes back—1915 is it, I think. Wallops Island [Virginia] was there as well, but all the entities that became part of NACA grew out of that center. So they all had a linkage, you might say. As a result, I think they had all had a tendency to work similarly.

Naturally, a lot depends on personality, but we had very good leadership in Washington as well. George Lewis was a key person for the whole organization. Then Hugh [L.] Dryden

came in and led it and became the deputy in NASA [when T. Keith Glennan became Administrator,] so there was a logical movement. That became the base, the foundation, for NASA, when you get right down to it. That and JPL [Jet Propulsion Laboratory, Pasadena, California].

RUSNAK: So you actually felt the effects of this leadership from the top down?

FINGER: Yes. Oh, yes. It was outstanding. And I learned so darned much from it. I worked for real giants. No question about it.

RUSNAK: What did you pick up from them in terms of a management style or philosophy that you took with you in later higher positions?

FINGER: It was, again, really encouraging everyone in your organization to participate. The best example I have of that is when I became—let me think now. I'm trying to think where that was. Well, wherever I went, if I had a staff meeting, essentially everybody was there. Yes, I might have special meetings with individuals, but, for example, when I went to HUD [Department of Housing and Urban Development], everybody was brought in. Then when I went into General Electric, and later when I took over an energy information organization, I always invited everyone in. In fact, one time, in the last job, in that job when I had an energy information organization with public advertising and everything, and emphasizing nuclear energy, the benefits of nuclear energy, I hired an outstanding guy who came from General Motors, [and] had done public information for them. And when I called staff meetings, everyone was there, including secretaries, and he would leave. He wouldn't stay in the meeting. And I said, "Look, we'd better have a meeting," so we had a lunch together.

And he said, "Look, it's a waste of time. … [I know] what to do."

I said, "Look, one of the things we're doing is going out on public information. I want to know what all of our people think about some of the ads we have, some of the messages we have. If any one of them has a concern, that could very well be a public concern. A question. I want their ideas." And that's what I maintained through every job I had.

At GE, when I went into GE and had a utility engineering operation in Schenectady [New York], as well as an energy organization in Washington [DC], I called everyone together. That theme of encouraging people to talk, to express themselves, to participate, I maintained all the way through. And I still think that's major, a major requirement for a good organization.

RUSNAK: Have you felt that was difficult thing to maintain in some organizations?

FINGER: No, I didn't. I must admit—now I'm going into more of a personal view of how things have [be]come since then—I believe that's been undercut in recent years in government, significantly. I really mean significantly. And, very frankly, I think within NASA there's a frowning—there was, at least, and with the former Administrator [Daniel S. Goldin], who was brilliant and knows the subject so well, and who I really think a lot of, I don't think he could tolerate anything that implied there might be criticism of something he had done. And that's contrary to everything I was ever involved with.

I remember sitting with [HUD Secretary] George [W.] Romney in HUD once, and he was decentralizing stuff, putting stuff [and organizations] out into the field and so on. And at a lunch meeting, I said, "Look, I think that's fine to involve those people. The big question you have left, however, is how will you know what's going on there and what decisions are being made, and assure that they're within the context that you've established and that you're emphasizing? So you want to encourage that, but it's distant, so how will you know?"

He said, "That's a good question." I mean, the encouragement for question was there all the time. And I still believe it's essential. I've had examples with a former Administrator in

NASA where he could not tolerate a question that he felt implied a criticism of something he had done, and he would erupt. That was totally contrary to anything I knew. I might say I followed him at that point and told him, "Look, you could have chewed the guy out for maybe giving a stupid question, but you didn't have to take it out on everybody at the meeting."

RUSNAK: Well, if we can get back to some of the work at Lewis.

FINGER: Yes.

RUSNAK: What knowledge did you have of nuclear power, propulsion, those sort of things, before you took this year of class?

FINGER: None. None. Well, I should tell you first, I had never done any work on compressors and turbines even in the educational programs I had at City College. I was working on steam engine stuff, things of that kind. Pretty conventional things. Supercharger. Knew what it was, what it was supposed to do to help an engine operation, but getting down to real testing on that, analysis of that testing, getting into really significant air flow work, I learned that on the job. The bulk of that I learned on the job.

In the nuclear field, I really had no prior training in the nuclear field [before the Lewis school]. I knew generally what fission was, but that's about where things ended. What kind of radiation do you get out, and how do you have to match up materials in order to establish a fissionable mix, and so on, no. That all came through that training and exposure to it, and then being, again, exposed to people who really knew that business, who were competent in it, like some of the people at Los Alamos [New Mexico], or people in some of the companies like Westinghouse that was doing work on the submarine program—General Electric, heavily, things of that kind.

You can almost ask the same thing, "Well, how did you get involved in HUD going from NASA?" Well, I mean, you have a concern. It happens. When I was asked to come to HUD, we were spending a lot of time in family groups, in groups with friends, talking about social problems the country was facing, and to me that was really important. But we ended up with a mix of social concerns, and working on social issues as well as technology. That's when I became the Assistant Secretary for Research and Technology in HUD.

RUSNAK: Tell me about after you finished this training class. What's the first work that you started on?

FINGER: I did some work on shielding related to aircraft propulsion, and also then added a piece on nuclear rocket propulsion because there was some talk about space rockets, nuclear space rockets that had been suggested. I think the first report on that was actually written by Bob [Robert W.] Bussard, I think in about 1955, and NASA, you know, wasn't established till '58, and the first Russian [Sputnik] flight was before that. But, still, '55 was when there was … [early] discussion of nuclear propulsion for aircraft as well as rockets. Work was started in that area, so I got somewhat involved in that in Cleveland, but not very much. It was more the shielding work that I was involved in.

RUSNAK: What were some of the key issues in shielding? Was it materials or—

FINGER: Materials and design. More design for particular applications. I have to say, at that point I was still learning, and it was more learning by actual practice with a very small group of people. It was a subject that I had. I didn't have an organization for that. Maybe a couple of people and I worked together on it, and we worked then in the Nuclear Division [which was functionally part of Ben Pinkel's Materials and Thermodynamics Research Division] in NASA.

Ben [Benjamin] Pinkel was the head of that division at that time. Frank [E.] Rom was involved in it. Still is in various ways.

RUSNAK: What did you think of the potential for nuclear power on something like an airplane at the time?

FINGER: Well, I have to admit I was very skeptical of it. You talk about nuclear energy when there's range involved, or the need for very high-energy propellant out of the fuel, but in an air-breathing engine it just didn't seem to me to make real good sense, because you're not carrying the major propellant, the air, with you, so it's just to heat things up. And that seems to me like you would add a heck of a lot of weight in a reactor just to heat air [, and for limited range].

Similarly, there was a ramjet program that was involved as well, and I got to know the people who were working on that later. I felt that, too, that it was air-breathing and using a reactor to heat. Aren't you adding a heck of a lot of weight to the system? That reactor's heavy, and then you have to put shielding on it, heavy shielding if you're having a human system. So that didn't make sense to me.

Now, on a missile system maybe it was better because you didn't need quite as much shielding, but, nevertheless, you had to have real protection in the system. But the reactor itself was heavy as could be. In a rocket it's different. Where you're carrying a very low molecular weight propellant, and you get very high specific impulse compared to the kerosene and things of that kind, so you can make up for that weight difference, so you get at least double or more thrust per pound of propellant, which is hydrogen, compared to kerosene….

RUSNAK: Do you have any concerns related to the environmental effects of nuclear power on an aircraft?

FINGER: Oh, well, yes. We looked at that very carefully. In fact, it's interesting. Since I was very early—well, before I answer that, let me break off a little and I'll—

[Tape recorder turned off.]

FINGER: Aircraft. Or did we finish that? Where were we?

RUSNAK: I had mentioned environmental concerns.

FINGER: Oh, yes, the environmental considerations. In fact, a very important point. I found that the safety considerations—and I'm departing a little bit; I'll come back to the environmental considerations—were things that we devoted a lot of attention to in the nuclear rocket development program to the point that—and in isotope power … [for] space application, because I also ended up taking over an AEC [Atomic Energy Commission] job on that while I had a joint office job with NASA and the AEC and a separate NASA job. So the safety standards and requirements were heavily [analyzed and] applied.

Then years later, I met somebody who was working on some of the space power work, from JPL, and she brought me a package of safety material that had been turned out when I was running it, and she said, "You know, these are still the standards we apply."

In the environmental area, the issue is clearly to avoid having the radioactive particles, materials, or anything, getting out, and that became a key issue related to the nuclear rocket program to the point that at one point in the development of the program, because we had had failures, I ruled out any further full-scale testing of a reactor in Nevada till we went through extensive component testing and so on, to solve the problem. I ran into serious problems with the director of Los Alamos on that basis. He's in one of the pictures.

I made that determination at a meeting out at what was then the Atomic Energy Commission … [office] out in Germantown, Maryland—we had a meeting there—and I said, "We're going to have no more testing till we figure this out." It was after [President John F.] Kennedy. That meeting was after the Kennedy visit to Nevada and to Los Alamos.

He [, the Los Alamos Director,] said, "If we don't test, the program will die."

I said, "I'm not worried about that kind of a thing happening. I'm worried about it dying because we keep failing." That was a matter of emitting fuel elements and radioactive material from the operation. That, to me, was absolutely something we couldn't accept.

Now, as it turns out, even if you emit some particles in upper atmosphere, that effect is really not only not significant, it's so darn small that it doesn't count at all.

So, yes, we thought about that. But, incidentally, I also got into some disagreement with them, and I'm busy reviewing a big [and important] report[book] that's being written by a Jim Dewar on the nuclear rocket program…. When I first got into the program in 1958, when NASA was established, and then took it over in 1961, Los Alamos wanted to launch, at least for flight test and maybe for missions, nuclear-propelled rockets from the ground. I took a position against that, saying, "No. I see no place where you could safely start that on the ground, have it hot on the ground, nuclear operation on the ground, and then try to launch. You may fail. So where is the safe launch site, a remote launch site that you're willing to sacrifice?" And I ruled that out so that when we talk about nuclear propulsion now, it relates to in a reactor starting in orbit so it's already in space, and it's cold, nonradioactive at that point, starts up from there and goes from there.

Now, with isotope systems you can't do that because they emit right to begin with, so you have to build a safety system around that, which assures that they can be contained even if they fail, even if they fall into the ocean or on the ground or wherever. And you launch them in such a way that they won't fall on the ground; they'll fall into the ocean. We went through all of that.

But I ended up disagreeing again with Los Alamos on that [ground rocket launch], and the general policy today is nuclear in upper stage, not a ground launch stage [, and the use of nuclear propulsion and power in space when it realistically enables necessary space missions].

RUSNAK: It seems with something like an upper stage, that's where you get the most advantage of a nuclear power anyway.

FINGER: Of course. For deep space. I get very concerned when some people say, no—and some of the defense people talk about having a nuclear system in orbit. I say, well, you could do that with an isotope system, maybe, so go to high altitude, high orbital altitude, but the fact is, solar energy's there for as much as you want, so maybe a little bit heavier, a little more costly, but you can keep recharging [so] as you go into the dark period, and so on, [there is] no problem.

In fact, I was on a study where I raised a question on that same issue. I don't know what they're going to do, but they've talked about possible missions for the Defense Department in orbit for isotope power units, and maybe it will make sense. I don't know. But for deep-space missions, for propulsion and power, you're going to have to have it. And for Mars missions and so on, you're going to have to have a nuclear reactor power system.

RUSNAK: Can you tell me what sort of work you're doing with the Air Force on the nuclear aircraft?

FINGER: What I was doing with them?

RUSNAK: Yes.

FINGER: I really wasn't doing anything with them. See, it turned out that much of that work got cut back—well, I shouldn't say that, because the Atomic Energy Commission and the Air Force had a joint office before NASA was established, and they were looking at both aircraft and rocket propulsion. The rocket propulsion was in relation to missiles, principally, and there were two labs working on it, Livermore [Lawrence Livermore National Laboratory, Livermore, California] and Los Alamos. Two AEC labs, Livermore and Los Alamos. They both were working on the rocket, and then it was decided, no, Los Alamos will do the rocket, Livermore will do a ramjet, an air-breathing ramjet for missile applications. It was called the Tory Reactor Program—no, it was called the Pluto Program, but the test reactors were Tory reactors. That's what it was. And that program got killed after one or two tests out in Nevada. It was after '58. Then I was involved with those people to some degree just to know what was going on, because some of the lessons there related to the nuclear rocket Program succeeding in that. But I really wasn't involved in any of the air-breathing work, and it died very quickly. There was clearly no benefit very early in the game.

RUSNAK: Maybe you can say a few words on the effect of the Soviets launching Sputnik and then the subsequent creation of NASA.

FINGER: Well, that was disturbing. There's no question, it really was, just because we felt, gee, we had to move ahead. To me, the remarkable thing is how quickly the United States moved forward in establishing a capability in that area and an organizational system for space activity, because within NACA, although there was some rocket testing, that was certainly not encouraged in NACA. Cleveland did a little work like that. John [L.] Sloop and a few other people did some work in that area, but very limited. So NACA was really not involved in that area—I'll come back at another point—but there's no question that NACA then very quickly was

put into the situation of having to work on developing the legislation for such a program, and it was clear they were going to be proposed to be the lead of that kind of a program.

Some of the congressional people really wanted the Atomic Energy Commission to be given that authority. [Sen.] Clinton [P.] Anderson, I'm pretty sure, wanted the Atomic Energy Commission to be given that responsibility. But, anyway, I wasn't involved in that. I never really got into that. I was very negative on that.

RUSNAK: I'd read in one of your previous interviews that you had some involvement in going over some of the wording of the Space Act and such.

FINGER: Very little, really. The Space Act was well set when I got into NASA. Paul Dembling got significantly involved in that, and a few other people, but I can't say that I really did. No.

RUSNAK: What did then the creation of NASA from the NACA core, what effect did that have on the work that you were doing?

FINGER: Well, the Saturday before October 1, 1958, I was in Cleveland. As far as I was concerned, I was going to keep working there. I got a call from Abe Silverstein, who was already spending time in Washington with a small group of people. We were just ready to go out, and I got on the phone and he said, "Harry, I'd like to have you come to Washington to work in this new NASA, new space organization.

This was Saturday. I said, "Well, when do you want me to start?"

He said, "How about Monday?"

And I said, "Okay." I didn't know what I was going to do or anything like it. I really didn't. And I accepted the job on that basis. It was fine by me.

[Tape recorder turned off.]

RUSNAK: We were just talking about how Abe Silverstein asked you on a Saturday to come work—

FINGER: On Monday.

RUSNAK: —on Monday.

FINGER: And every Monday morning a plane would come down from Cleveland, from the Cleveland airport down to Washington, we'd live here for the week, go back on Friday. Did that for a few weeks. That was in October, and we moved here in December, that fast, all of that, and without any question to what I was going to work on.

Now, I will tell you that when I came here, the fact is, there was a pretty good group of people from various of the labs, from Langley—Ira [H. A.] Abbott was over a big chunk of it. Abe was over another piece of the organization, and he had people not only from Lewis, but from other labs as well.

The best description I have of the room we were in, for example, is, it was like a classroom where Abe sat at the front on one side, not in the middle, facing all the rest of us. We had desks—about four, as I recall—in a row, looking up at Abe. We worked together, we lived together, we ate together, and we went looking for places to live here together. We, I think, really developed, again, this team concept. Here we were in the same room with our boss, you might say, and in close association with others, and, again, there was that freedom of discussion. Each of us ended up with assignments. We didn't necessarily get the assignment right away, so I ended up—I think you have my biographical sketch—.

RUSNAK: Yes.

FINGER: I ended up, as you can see, right away with an emphasis on advanced propulsion, nuclear power and propulsion, and so on, because of the background I had in that school that Abe had set up. And I guess that was one of the things he wanted me to come work on.

But that led very quickly to the whole issue of how NASA would take over that nuclear rocket work that was being conducted by the joint office of the Air Corps and the AEC. And because the president made the determination that that responsibility would be transferred to NASA, that was a blow to the Air Corps, I would say, at least to the people running it. General Keirn was over it all, but Colonel Jack Armstrong was in it. There was Colonel Howie [Howard R.] Schmidt, Major Ralph [S.] Decker—when we ended up with my heading the joint office of NASA and the AEC in that area, … [but] it was a lot more complicated than just happening, Howie Schmidt and Ralph Decker were moved in so we had a few Air Force working in it as well.

But the Air Corps—Jack Armstrong just didn't like that switch at all. No question about it. But it was, I would say, [NASA Administrator T.] Keith Glennan who really fought … to get that office established as a joint NASA-AEC office, or AEC-NASA office. John [A.] McCone was the head of the AEC, and I don't know if he was really deeply interested in making the switch or not. He could accept it, I expect, either way, so it took Glennan's persistence on it. But it took a heck of a lot of political effort on his part, because he had major congressional people opposed to the transfer, Clinton Anderson especially. He, after all, represented New Mexico. Los Alamos was there. They were already working with the Air Corps. They liked it that way.

There were some contractors who were involved in some of the test equipment—turbo pumps, nozzles, and so on. I think they all felt—they couldn't voice anything related to it, and they knew that organization. So it took a couple of years—'61, I think, or '60. I can't

remember. '60 or '61 [August 1960] before the transfer was actually made, and I participated in all of the discussions and all of the decisions even before that time.

Then when the transfer was made, I was made manager of the joint AEC-NASA Space Nuclear Propulsion Office. I still headed the NASA activities because the AEC would handle the reactor and be involved in the engine, but the vehicle would be NASA. Then later I got another job as heading the isotope power work in the AEC.

My deputy in the joint office was Milt [Milton S.] Klein, who had been working at the Argonne National Laboratory [Argonne, Illinois] system for the AEC, so it was a joint AEC-NASA operation. I think we established ourselves very quickly. We built a good team of people, and worked well, I think, with all the organizations that were involved. I can tell you that Clinton Anderson was not happy for some time, but then it wasn't too long before, in a couple of hearings, he said he had been wrong. He said, "You're doing a good job," in the public hearing, and I have the records to show that. [Laughter] So it all worked out really well.

RUSNAK: Why do you think Glennan was so persistent in getting this for NASA?

FINGER: Well, I think the broad feeling that it had to be civilian. It was not going to be a military system. And it was going to be for [space] exploration. The aircraft business, basically, was going to be eliminated, and even if there was aircraft application, then, again, civilian. The military—the missiles side—really died because there were missiles developed, chemical missiles that could do the job. And that application died.

But the fact is the president actually had made that decision very early, right when NASA was established. He said it was going to be transferred. So the issue was, how do you effect the transfer? And that's what Glennan was charged with doing, and he did. Did he have questions about it? His concern was, how will you be able to launch the system? What will be the acceptance of it? Things of that kind. The normal things, to the point that Jim Dewar then

writes, "Glennan was antagonistic to the program, and so was Dryden." And I said, "Heck, no, I worked in it. They weren't. They raised valid questions." [Laughs]

I've been reviewing that thing [book]. I've got cases of it. He's been working on getting it published, and it's going to be published by Kentucky University Press.

RUSNAK: I was reading in Glennan's diary that there was some opposition to you particularly being in charge of this. Do you recall why that was?

FINGER: Well, did he indicate the source of the opposition? Because I think, again, it was Clinton Anderson. Part of it being that I came from Lewis. Very specifically, there was a study that was done by RAND [Corp.] after … [Ben] Pinkel left Lewis and went there, and there was work going on on nuclear propulsion at Lewis, but not related to the same configuration that Los Alamos had picked…. It talked about tungsten systems and so on. And RAND had come out with a somewhat negative report on the technology that came from … [Los Alamos], so he was angry that this guy from Lewis, working at RAND, was leading this study. And even when we established the joint office—related to assuring that people worked together, I also always felt you had to have very strong technical capability in the areas that you were managing. I still feel that way, and I think there are some problems occurring recently on that subject.

But as a result, I set up an [extension] office, reporting to me [in the joint office], at Lewis to work on engine systems and technology using the know-how within Lewis. I set up another one in New Mexico, in Albuquerque, to work with Los Alamos [and I also set up an extension at Nevada Test Site to link more fully to our tests there]. Later on, when we got to a vehicle, [in my NASA role], I set up one at Marshall, when the Marshall Space [Flight] Center [Huntsville, Alabama] became part of NASA, to have a capability that reported to me so I would have really solid technical know-how supporting my work.

And there's no question that Anderson was very opposed to having anything at Lewis involved with this because he had the notion that they were opposed to nuclear energy and to the concept that was being worked on. I think that had a lot to do with it. But beyond that, I don't think there's any question that he favored the Air Corps people, and he even talked about having them lead the work, even if it was a NASA job.

Yes, they did have concern about me, and I don't think it was on technical grounds, but that was reversed later when Clinton Anderson came out—and he literally said, "I was wrong in opposing you. You've done a great job." He specifically said that, and that's where I think the opposition was.

RUSNAK: It was nice that you got that validation from him eventually.

FINGER: Oh, well, I'll tell you. [Laughs] It was very helpful. It was—no question. Because it was a real worry. And it inhibited Keith Glennan quite a bit. In fact, one time, Anderson—before I was appointed, Anderson made a talk where he included some quite negative remarks about me. Glennan wrote a letter to him indicating that he was in error, that he was wrong. Of course, he didn't respond to that, but later he did.

RUSNAK: What can you tell me about Glennan as a man and the Administrator, and just how he managed things?

FINGER: Well, first, you should remember that in—let me think now—[nineteen] fifty—whenever I got my master's degree in aeronautical engineering, I went to night school after being in NACA. … But I got that from Case, and he was president of Case Institute of Technology [Cleveland, Ohio], so he handed me that degree. So I had at least that [very limited] contact with him. That's all.

Again, he was a guy you could really be open with, fully open, just like Jim [James E.] Webb later, bringing in good people, talking with them, encouraging them to participate, and all the rest. It was a very open situation.

I'll never forget one big meeting that he had when we were starting with Marshall to talk about the Saturn V vehicle for manned space flight. That decision, you know, was made under Glennan, to start really working on men in space, and so on, and having a vehicle capability for that. That led to hydrogen upper stages that Von Braun wasn't keen on, but Abe Silverstein was because he knew hydrogen—and, incidentally, that goes back to the fact that in NACA there was work done on a hydrogen-propelled aircraft, and if you used hydrogen propellant, again, that reduced the need for a nuclear capability in aircraft propulsion. Just hydrogen fuel, you know. So it worked out very well.

So hydrogen capability came heavily from Lewis, and the Saturn V had that upper stage. In that big meeting in the basement of the Dolly Madison House—which is still down there, and that's where the Headquarters of NASA was when it was established, and the Wilkins Building next door, and most of us were in the Wilkins Building. I was in there. The Marshall people were already part of NASA. There was a big discussion about the configuration of that vehicle. I can't say that I was a very forward guy or anything like that. In fact, if anything, I was, and I think I still am, a little inhibited in standing up and voicing my view in a group, and so on. But I had no hesitation, with Glennan at the front of that table, with a pretty darn big group from all the labs, standing up and saying, "Look, I think you ought to make that first stage of the Saturn V big enough in diameter so you can anticipate having an upper stage with a nuclear rocket, and you're going to have to have it in large volume to take care of that low-density hydrogen [propellant] up there. It's going to be really large. So I suggest you make the diameter of that first stage as big as you can. And if you want to limit it to the [vehicle assembly] facility, make it as high as the hook height in the place where you're going to build the stage."

The next day—oh, by the way, at that time I was in another office on Pennsylvania Avenue. NASA took over another office there. In the elevator there, I ran into Eberhardt Rees, who was Von Braun's deputy, and Eberhardt said to me, "Harry, what are you trying to do? Have a pinochle game in that vehicle?" [Laughs]

And I said, "No, you know what I'm trying to do."

But the relationships were that way, across the board, and there was such a real team sense that I felt in dealing with all these people, and it didn't matter how high you went. It was a lesson I learned from then on … wherever I went.

But, anyway, we worked, I think, pretty well in getting that vehicle, the Saturn V, designed. And it was the hook height in the Michoud [Assembly] Facility [Louisiana] that made the determination of the diameter.

RUSNAK: Glennan was obviously only there for the first two years of NASA. When Kennedy comes in, of course, he's going to bring his own person in—Jim Webb.

FINGER: Right.

RUSNAK: Can you compare the two men for me and then maybe what changes the departure of one and the introduction of the other had?

FINGER: Well, I can't really contrast it very much. There's no question that Webb had a very broad-scope vision of things, and I'll come to that in just a minute. Maybe more than Glennan, although Glennan had a very broad-scope vision.

Now, you have to remember the objectives weren't as clear. When he came in, we were going to develop a capability to do things, and we would start with some small missions along the way, using whatever was available wherever we could, but there was no question we wanted

to go to man in space, so we had the astronaut selection process. Wasn't that with Glennan? Yes. The first seven astronauts? Yes. So he was setting direction as well as starting to try to build the capability, but it was still darned early, and there's no question that it was a matter of showing the world that we had technical competence.

Webb came in, that was still the same theme, but some of the technologies that we were moving ahead with were already there. Certainly we were already working on the nuclear rocket, we were already working on getting a big Saturn V vehicle, so some things were already set, but he broadened it. For example, even though Glennan emphasized education, Webb *really* emphasized education. He felt very strongly about getting universities involved. In fact, when we ended up picking the contractor who would be involved in building the first nuclear rocket engine, we ended up picking Aerojet General as the overall engine contractor, with Westinghouse as the reactor contractor. The main question I got—I was chairman of the Evaluation Committee, let me put it that way—was, "How are you going to use the universities?" And in everything he did, that was a major issue, to the point that he had a person in charge of university research activities.

Another one was, what are the technology benefits that derive in the civilian sector? So he had a technology utilization organization that was a very major element.

Overall management was a significant thing. He actually went out searching for management people and key individuals that he might fit in in various ways, even if they didn't necessarily lead an organization.

He himself, I would say, became the major presenter on the Hill on the broad scope of NASA's program. He had just come in a very short time before when at one hearing on the nuclear rocket program, Norris Bradbury, who was the director of the laboratory back here—well, this is Norris Bradbury and Ray Schreiber there. Came in and they came over to our house before the hearing. The two of them were going to be testifying, and so was I. That evening we talked over the testimony—let's see, Schreib is not in this. This is Seamans. But this is

Bradbury at the director, and there's Schreib, who headed the rocket program. They came in, and it was in that hearing—and they were pushing the ground launch system for a test—and I indicated to Congress that there were certain concerns that we have about that possibility so, yes, that's a possibility, but it's more likely we'll have a chemical launch system with an upper stage.

I remember Jim Webb was standing at the side. He had just become Administrator. Later, he asked me, "Why were you negative on that approach to flight test? The Congress was supportive."

I said, "Because I really don't think it's a sound approach. I have great difficulty with the thought of how we would get acceptance for that kind of a test where you launch from the ground. We don't know how assured we'll be that the system would operate effectively, and could there be emissions right there at the test site. And then you can't use that test site again for some period of time till there's a decay enough." Things like that, you know. He bought it, but he had that kind of question.

Later we went to hearings where, since it was a joint office, Jim Webb and Glenn [T.] Seaborg would be testifying. One of the guys, Sid Krasik, I remember—in that picture of the nuclear rocket engine, an outstanding Westinghouse scientist engineer—came up to me after the hearing, and he said, "You must have spent a lot of time with Jim Webb on that."

I said, "Why? I didn't spend any special time."

He said, "Oh, he did much better than Glenn Seaborg." Glenn Seaborg, Nobel Prize winner, scientist in this area. But in terms of presenting the program, its significance, the obstacles, the benefits, I don't know anybody who could beat him.

Glennan did a super job in presenting all of those things as well, but I think maybe partly because I was longer with Webb, maybe closer to him, I felt that way. I should say, with both of them, I maintained contact with them after they both left NASA. Although I don't have contact with Glennan's wife after he passed away, I still contact Webb's wife after quite a few years, so I'm still in touch with them.

RUSNAK: Let's talk about actually you setting up the organization to run the Space Nuclear Propulsion Office, how that worked, how functionally the AEC and NASA worked together on this.

FINGER: Oh, really very well. Frank Pittman, who was the head of the division in which the joint office was located in the AEC, was a pretty able guy, and he had been there for some time. He later left, and a fellow by the name of John Swartout came in.

In NASA it was—well, the first one—gee, I'm having trouble pulling out the first name. Oh, gad, I know him so well. Gad. It's one of my elderly problems where I can picture the person so well. I'll probably think of it, I hope. [Abe Hyatt]

But, anyway, the first guy left. In fact, it was at a certain point when he became head of the organization that I was in—advanced propulsion, it was—gad, I'm having trouble pulling it out. I came back and told Arlene, "Arlene, from now on I'm on my own, really. There's nobody in there who knows as much about it as I do, so that's an added responsibility. I'd better be damned serious about it."

But following that, an Air Force guy came in, General Don [R.] Ostrander came in, and I think he was there for a couple of years anyway, a very able guy. He headed the program, spoke a lot on nuclear rockets, and so on. Incidentally, he came from the Defense Department and had headed, in the Advanced Research Projects Agency, the Orion Project, which is the bomb propulsion project. When he came—in fact, I have the book on that—when he came, he asked NASA to take it over, suggested that NASA take it over, and he asked me to lead a team to go out and review the program, which I did. We had meetings out at General Atomics. This guy, Ted Taylor, was busy working the program, and Freeman Dyson, a top scientist, who was, and I guess still is, at Princeton, was in charge of it, and it's George Dyson, his son, who wrote that book.

I came to the conclusion that it was a nonusable concept, and in the meeting, I said, "Look, I can tell you what our report's going to say. We haven't written it yet, obviously. I see no way of testing it, actually. You may talk about testing it in flight, but nobody is going to take the chance of putting up a system that has not gone through extensive ground testing before you take the risk of putting it to flight and not knowing what'll happen. And I know no place where you could do the ground testing. I also know no place where you could do a launch—," because they were talking about ground launch, things like that. So, fundamentally, I killed the program, and that was in about '61 or '62, while Ostrander was there.

The issue kept coming up. In '63 NASA put a little money into it because George [E.] Mueller and some of the people on the Space Flight thought maybe it's worth looking at, and they wanted to set up an organization to study nuclear propulsion and the alternatives, and I said, "I see no reason to waste our time studying that one." And that's the way it ended up. I've pulled together a lot of background paper. There's one that I can't find in the NASA History Office, which troubles me, and that's a paper that I wrote rejecting the concept. The original report. I can't find that report anyplace. So it may still be classified, for all I know. But anyway, that was the situation.

So, again, we looked at various concepts. I'm not sure why I interrupted to bring that up, what question you asked that led—

RUSNAK: We were talking about initially setting up and organizing—

FINGER: Oh, yes, oh, yes. So what I did was I actually called in people that I knew into the original Space Nuclear Propulsion Office that I thought could help us, as well as people who were already working for the Air Corps AEC program, including the two Air Force people I mentioned, and Howie Schmidt took on a lead position in that area.

Incidentally, he resents the fact that he was not named deputy to this day. Just recently he mentioned that and implied that I was opposed to it. I said, "Look, I had nothing to do with that. They appointed Milt Klein. I didn't know him at all. But the idea was, it was going to be an AEC man and a NASA man, and you're an Air Force man. You were—."

And then I called other people that I knew, like [F.] Carl Schwenk. I'd worked with him in Cleveland, at Lewis. And there were several others like that, that I called in and worked together. Then I set up this extension office. I set up extensions, an extension office in Cleveland, Albuquerque, actually one in [Jackass Flats, Nye County] Nevada, also, for the test operations. Bob [P.] Helgeson headed that. And later, when we went to the vehicle, at Marshall.

The Lewis office is the one that really did the oversight of the engine work, the NERVA engine, Nuclear Engine for Rocket Vehicle Application, is what it was. And that became a small, very active office, and I was very reluctant to add people unless I knew I had a really significant function for new people, so it stayed small through the whole operation. And every one of them had major responsibility.

RUSNAK: How did the AEC people feel about NASA's involvement here?

FINGER: That was fine. Oh, that's where we were. I mentioned Frank Pittman, Swartout, various other people. The relationships I had with all of them, as far as I was concerned, was excellent. I mean, right to the top. I mean, to the commission. Really very good. I just didn't feel any real problem.

Other people—later I found out that Milt Klein had had some problem after I left. He was my deputy. He became head of the office after I left, and apparently there was some difference in view. I don't know what that was, but I never had any problem of that sort at all. None. I never felt any problem. We worked and expressed ourselves well.

[Tape recorder turned off.]

RUSNAK: We were talking about the organizational setup of the office.

FINGER: Yes. Incidentally, one other thing I should mention. We set up a very strong Safety Office in it. One of the Air Force people, Ralph [S.] Decker, headed that office, and that office, to a large extent, continued to operate long after and across many of the nuclear applications in space. But that was a key element in the whole operation, and even in our tests we did major work tracking any emissions to see if there was radioactive emission from some of the tests, where it went, how much it was, and the thing is, we were never inhibited in testing. All of our tests were upward firing in Nevada. We looked at the ground below it, and so on, you had no problem going right back into those test sites after any of the tests.

I should tell you that the big problem we had was that we did have failures of fuel elements. We finally prepared what we thought was the right [reactor] system design and test [just a week] before [President] Kennedy came out [to visit the site]. [We] ran that test and the fuel elements came out. And when Kennedy came, we really didn't know what the cause was, but we indicated there was a problem that we'll have to examine. When we examined it and I saw fuel elements come out, it turned out that part of the problem was that a seal had been put on the wrong end [of the reactor]. It had been put at the front end so all the fuel elements could expand and vibrate instead of at the back end of the reactor. That was one element of the problem, but there were vibration problems.

RUSNAK: This was the Kiwi-B4A test?

FINGER: Yes. You've looked at it all. Okay.

RUSNAK: Well, we like to do our research.

FINGER: And then that's the time I called the meeting. I called people from Langley because of their work on vibration of aircraft frames; at Marshall; at Lewis; Los Alamos, obviously. And I called a meeting, and that's when I told Norris [Bradbury]—I just made the decision, by the way. I didn't ask the commission or anybody else about that decision; I just made the decision, we're not going to do any more [reactor] system testing till we figure out what that problem was and till we have it solved.

I allowed just one cold-flow test, just hydrogen flowing through, no fission process. After I ran that test and we actually saw the vibration—I encouraged that test, and then we did component tests—I got a letter from Norris Bradbury saying, "Look, that was a very good test. Glad you required it, but that doesn't change my mind about the need for hot testing." Something like that.

It took a year and a half of more detailed analysis and testing before we came to a conclusion that we had the solution, and every test after that worked fine. Well, Kiwi-B4[D] had a [nozzle] failure, but that was a trivial thing, and every one after that just added operating time to the systems. We could restart and everything else with no problem.

But before we got to that point, … [President Kennedy] was there near the end of the year, we were talking budget, what the next year's budget would be, and I remember meeting with the commission—and this was, again, a matter of how I think you have to talk sometime, the position you have to take. This is a five-member commission, and they had a big conference table in the Germantown office. There were the five commissioners, Glenn Seaborg and Jim Ramey, [Gerry Tape] and a lot of other people that we're still friendly with. Of course, Glenn Seaborg died a couple of years ago—three years ago, I think.

And here I was, alone on my side of the table, and they said, "Okay, we're going to the Bureau of the Budget and recommend a flight test, present a budget for a flight test."

And I said, "You have a problem. How do you go recommend a flight test when we have a problem that we haven't solved yet in the reactor itself? We don't have the vehicle or anything. How can we go?" I said, "I've got a ground test program that I think we should really pursue before we talk a flight test, and let's get ourselves into a sound position."

And they said, "No, we'll go for the flight test, and if we can't get that, then we'll back off and go for the ground test."

I said, "Well, I don't know how you go to the Bureau of the Budget, but I don't think you go to bargain with them." I remember those words, and it was spontaneous.

And they said, "No, that's what we'll do."

I said, "Okay, but I want to be sure you know that I've got a ground test program."

I then went to see Jim Webb to tell him what had happened and what my concern was, and he said, "Well, do I have to support them when we go to the Bureau of the Budget?"

And I said, "Well, I think you should, but I want you to know that there's an alternate." And, sure enough, when they went to the Bureau of the Budget, I got a call to come over to the Old Executive Office Building, next to the White House, to talk about preparing a justification for the ground test program. And that's what we got. And that's what we pursued. We just quit talking flight test. We cancelled the reactor flight test system.

But it took that kind of a position, and to this day I've always felt you have to be sure, pretty sure of what you're doing. Now, you can take risks sometimes, but not risks where you have major problems and uncertainty. You can't do that. You really have to understand that you know how to solve the issue. And in this case there had been many tests. Every one had a failure, from the very first one. And it was presented as a great success. Well, I'll accept that the very first Kiwi test might be considered a success because you had to get into use of the operating system and the test facilities and everything else, and when "Schreib," Schreiber, said it was a success, I just let it ride. I didn't press that. Okay, you get experience. But it got to the point, when Kennedy was there, we thought we had the solution. We thought we had it fixed.

I will also say I also took Schreiber to Livermore, where they were doing the ramjet tests, to talk to the people there about the comparisons, and that's where some of the vibration problems were discussed as well.

So it was a matter of drawing in as much capability as we could, and that's part of the concept that I had there and everywhere after that, on really having in-house capability. I mentioned before that I have a worry about NASA that way today, and, overall, government because the emphasis in government today is to contract out, get contractors to do the work. And I maintain that's great, you can get really good people, but you better be doing some of that work yourself in-house in order to be sure you have an inherent capability to judge what's being done by those contractors. Because you never give away the responsibility in a government agency. I've used that term a lot. You cannot relinquish or reject the responsibility assigned to you as the head of a government agency, or a project manager in a government agency, or anything like that, and blame a contractor. Can't do that. You've got to maintain that capability. That usually means doing some in-house work in that area.

That's where I believe NACA was especially strong, and I believe, also, why NASA was so strong to begin with. The people that led the programs were people who had been doing work themselves, and they went out to contractors, in many cases contractors who were not as equipped as contractors are today because they've got a lot more experience. But, nevertheless, there was an in-house capability that was really strong, and, I believe, essential. And that's what I tried to do when I went to HUD, when I went to the General Electric program, bringing in people who had knowledge in that area and had worked in those areas in order to have some real feel for what we were getting done.

RUSNAK: That's like the point you had made earlier about the importance of technical competence on the part of managers.

FINGER: Absolutely. In fact, I'll be very frank with you. When Sean O'Keefe was just assigned as head of NASA—and my impression of him is really very good—my first question was, how is he going to get somebody who's a deputy who really is solid in the technical side of things? Sure, he's run major organizations—Secretary of the Navy—he has a concept and knowledge base in some of the technical areas, but not a deep knowledge in those areas. And it seems to me that they've pulled some people together who do provide him that technical know-how, but you still have to have more in-house work done in NASA in order to have a sound, solid technical base on the major issues.

And that includes at Houston. A lot of the people at Houston, let's face it, Bob [Robert R.] Gilruth was an outstanding technical man who came from Langley, and I knew him, worked with him. Really solid. And he had a team of people with him who were just that solid, and also were not afraid of expressing themselves in any way.

And when I think even of the Apollo mission, where you had a guy from Langley—I mean, it was going to be a direct flight up to orbit, and so on, and you have somebody from Langley [, John Houbolt,] saying, "I got a better way." Speaking up. "I got a better way." That's the way it was—you know, things like that.

So you have to really look for that, and with the emphasis in this administration right now—and, by the way, I support this administration—for outsourcing, the term "outsourcing," contracting out. I say that's great, but tell me, how are you going to maintain your in-house capability and build it where you don't have it? And that's a real concern on my part.

RUSNAK: I think that's a concern on a lot of people's parts, especially as a lot of that technical capability in NASA is getting older, and so those people retire, but they don't have the ability to hire new people.

FINGER: That's right. And how do you bring new people in? How do you present them with an enthusiasm for the work that used to be there? I mean, look, here was this whole gang at City College that … proposed [going] to NACA. It was an outstanding opportunity. How do we present that today? Because we've got to renew that capability. You can't just be a manager of a contract. That doesn't do the job.

RUSNAK: Yes, I've heard from a lot of different people that when they got out of college and sent an application to NASA, that it was the lowest paying offer they received, but they went here anyway because there was that enthusiasm for what was going on.

FINGER: Kevin, I looked at some old papers—I've got to write a memoir on this whole program, the nuclear rocket program, for a World Space Group [Congress] that's going to be meeting down at Houston. They meet various places in the world, but they're going to be meeting in Houston in October, so I'll be there for that. But I looked at some old material. When I took that job, my salary, when I took the NACA job in May of '44, was $2,000 a year. We worked Saturdays so it added—I think I made $2,440 a year. Look, I didn't ask—of course, inflation and everything else, that was fine at that time. It sounds damned low now. [Laughter] But that wasn't the issue. I didn't ask. And when Abe said, "Come to Washington," I didn't ask "What am I going to be doing?" I find today young people talk a lot more about—I don't know, you may be able to attest to that—"So what, really, will I be doing? I want to know. And where might it take me?"

And, frankly, I see that a little in my grandson. He's twenty-nine. Yes, I think twenty-nine—my older grandson. When he thinks of a job, it's "So where am I going to go from there?" I never thought of that. I keep saying, "Look, I don't worry about that; I just figured I'd do the best I could on that job." I would learn from that job. Maybe it would open new things, but I

would be regarded reasonably in that organization. Maybe that would lead to something in that organization. I don't know. And that's, I think, reasonable.

But people tell me things have changed today, and maybe they have. I don't know. I probably don't understand it all.

I'm sorry to get into all that.

RUSNAK: No, not at all. I think a lot of things have changed between then and now, and maybe that's just one of them. It's funny, because I'm amazed at how many people who joined the NACA or NASA forty, fifty, even sixty years ago, remember to the penny how much they made when they first started.

FINGER: Well, 2440 is the number I always use, then when I saw this thing, it says 2,000. Then I got a pay increase—it didn't include the overtime—then I got a pay increase to 2430. [Laughs]

RUSNAK: Sure doesn't sound like much nowadays, does it?

FINGER: No, it doesn't. It didn't matter. I was just getting started.

RUSNAK: Yes, there are these somewhat apocryphal stories about how people wouldn't cash their paychecks. They'd just leave them sitting in their desk drawers for weeks at a time, whatever.

FINGER: I've heard that, yes, I've heard that. But as I indicated to you, with that I still had to go borrow from my boss a deposit on a car, which, fortunately, I didn't lose.

RUSNAK: Yes, fortunately.

The point you were making before we went off on this tangent, got at the heart of my next question, which was how was the technical side of things divided up between the AEC and NASA and all the contractors?

FINGER: Oh, very clear. In fact, there was basically a memorandum of understanding on that. The AEC had responsibility for the reactor, the Kiwi tests, and so on, and also follow on into NERVA. And the[ir] funding was associated with that. NASA had responsibility for the overall engine, and application in the rocket stage, and funding for that.

The flight test work would have some joint funding depending on what the objective of the test was. Actually, that's all written up. I don't know if I have that in here. Wait a minute. Oh, yes. [Reading] "Funding responsibilities for Kiwi-NERVA Program. To be funded by the commission, the research, development, design, and fabrication, testing of reactors, including both nuclear and nonnuclear components, except the hydrogen turbo pump and nozzles." That responsibility, through the Kiwi tests."

NASA had testing of the pump and nozzles and specific nonnuclear concepts. The ground development phase and so on went to the same corps. All parts within the pressure vessel, the reactor, was AEC. NASA had the components and subsystems of the engines other than the reactor core control drives. We actually had a full definition of that.

What was this? Nuclear Safety was the commission. [Reading] "Nuclear Health and Safety in connection with the nuclear hazards of nuclear power for space. Service work was mixed in personnel." Mixed. Man, how'd I pick that out so fast? Actually, I picked this up fairly recently. I had it someplace.

There's a broad memorandum of understanding, which was signed by McCone and Glennan in '60, in 1960, August of '60. I said '61 before. I knew I was wrong.

That basically defines the responsibilities as well. The basic memorandum of understanding. All that was set up.

I'm pulling all that stuff together. I've got it someplace, but I'm having trouble finding it in my storage. We've got a storage closet downstairs with boxes, and we have a lot of stuff like these still in boxes, so I went to the History Office and picked up some of that for this memoir that I'm writing, just to have it available.

All that has changed now. The Department of Energy, now, on space power systems, isotope power systems, they used to pay for the isotopes and so on, when I headed that program. Now, if NASA wants a isotope power system, the DOE is saying NASA has to pay for that. And on the nuclear power supplies and propulsion that NASA is talking about now, the people in DOE have told me that NASA has to provide the funds for that. That doesn't sound right to me somehow.

RUSNAK: So the DOE would still have the responsibility for it, but NASA is willing to pay for it?

FINGER: That's the implication. I'm still checking that, (because it also turns out that Sean O'Keefe, maybe because of his Navy background)—I'm having some e-mail discussion with Gary Bennett, who used to be in NASA and is now out in Idaho. He's retired but still very involved in all of this work.

Sean O'Keefe was Secretary of the Navy, and he's gotten a former Navy guy to come in and handle some of the advanced propulsion areas. I think that's related to his familiarity with the Navy submarine people and organization for work on the nuclear propulsion.

Now, the fact is, that group is really solid, that submarine group. So I don't resent at all him going there, but I wish he would also use the DOE people who've been involved in that kind of work for some time. And I hope that there's some merger. I have to call the DOE people to find out how it's actually going to work, and the NASA people. I just don't know.

RUSNAK: Yes, I had wanted to talk about this before we had wrapped up, but maybe now is a good time to have a little bit of discussion about the current efforts to reinvigorate these advanced propulsion concepts.

FINGER: Well, I'm gratified by it in several ways. Just to give you an example of some of the kind of arbitrary decision-making that existed before. When NASA was talking about having a Pluto mission, JPL was assigned responsibility to lay it out. The … [administrator] passed it on to JPL, naturally, and JPL came back with the conclusion that you had to use nuclear propulsion to get you there. Now, you could use nuclear power and later convert that to propulsion use, but it's so distant that you really had to use nuclear propulsion, otherwise it would take extremely long to get there.

The Administrator rejected that. They went back three times, coming back each time with nuclear propulsion before he actually accepted it. It conveyed sort of a negative image that he saw about use of nuclear energy, somewhere in the administration, or somewhere, and I can't really tell you what because I don't know what [his] full motivation was. I'm making an assumption, and there's no question about it. But I fault him, and others, not in NASA alone, but in other agencies, who sort of make their decisions based on what they *think* will be desired, accepted, approved, rather than making the case for what the[y] feel is really necessary to do the job.

Now, maybe Sean O'Keefe has turned around and feels, "Okay, here's an administration where obviously nuclear energy is somewhat accepted," somewhat more accepted, so he can do that. But I think it was also the science community within NASA that came back saying, "Look, if we're going to go out into deep space, we can't spend years traveling out there." And, similarly, if we're going to have humans eventually go to Mars or someplace, you're going to have to do it [with nuclear propulsion and power].

Now, the first things are for electric propulsion, for deep-space science, and I think they use both reactors and isotopes in that mix. I'm not absolutely sure of that; I'm still checking on that. But my understanding is that they're talking about both reactor and isotope work in that area, maybe with the first emphasis being on isotope. They're not talking about therm[al] propulsion, like a nuclear rocket, yet. And my view of that is fine. Get going, and let's get some work started on it, because you fundamentally have to rebuild the capability.

I mentioned earlier that in this nuclear rocket program, that program proceeded really outstanding[ly] well to the point that we could have run flight tests, we could have run mission tests. We had reactor tests that went for an hour with restart, multiple starts, working fine, well over an hour in total time, so you could have used it in a mission. The thing is, there was no mission. So it's sitting there. Now my question is, if you ever wanted to rebuild it, what is the capability you need? Because the really topnotch people who were there are largely gone. There are a few around, some in industry, some in Los Alamos, not working at the lab necessarily, but a couple of these people, and other really solid technical people. I have some know-how of it, but I think you need the really solid technical people to do that. So I don't think I'm as significant as they are.

So you have to find a way to rebuild it. That means get people to work in those areas again, and you'll then be able to draw back that knowledge base and maybe even extend it further. So I'm gratified by this decision that's being made and, apparently, going to be supported.

RUSNAK: Do you know how much they're working with the knowledge base that you created back in your day?

FINGER: No, I don't, really. As I mentioned, it's not the thermal rocket; it's the electric side. My understanding is that they're working with some people, some from Lewis, who were

involved—from Glenn [Research Center], I mean now, who were involved, and also there's a group down at Marshall that's involved in it. And, as I indicated, my understanding is that Sean O'Keefe has brought in somebody from the Navy who may have some knowledge base from the submarine business. But I don't know that anybody from Los Alamos, for example, has been involved, nor the companies that have worked in these areas. And not many of the companies have retained a reactor capability in any of this. There's a lot of isotope capability, but not reactor capability. So you'd have to rebuild some of that, and I'm not sure how they're going to go about doing that. And that's another reason I have to get together with some of the Department of Energy people on that subject, that I know who are still there.

But at least there's a movement in that direction, which is, to me, very encouraging. I was delighted. I will tell you, some of the people who worked on the nuclear rocket program are upset because it doesn't include thermal rockets. I said, "Look, thermal rockets, if you were going to have humans go to Mars, yeah, that's what you'd want, but for science missions, electric thrust is fine. So why not go with that to begin with? At least get back on track somehow in building a capability. So don't object." I said, "Don't fight it."

RUSNAK: Can you compare the relative merits and issues with the isotope systems versus the reactors?

FINGER: Well, it depends on what thrust power level you want. There's no question about it. One of the problems I see today is we have to go out and buy our plutonium, and so on, from Russia. We don't have any. We've quit work in isotopes, totally. You know, all our medical isotopes, essentially, come from Canada. We have no isotope production in the United States. So I think that's another issue that has to be addressed. We've got to get back to having some of our own plutonium isotope production. Not only plutonium; I'm thinking of medical isotopes and others. It's a significant area, and it's really critical for medical treatment, but it's also

critical if we're going to have a significant program on isotope power production in space. I'm not sure how much we want to encourage Russia to be producing those fuels.

Savannah River [Site, Georgia] is objecting to some of the emphasis on isotope, and that's where I think there would be some. Also, they're shutting down some of the major reactors, like the Fast Fuel Test Facility up in Hanford [Washington]. Things like that. And that seems wrong to me. So, again, we have to get back to building back that capability.

That's a broader problem. That also relates to the aeronautics deficiency that I mentioned, because we're shutting down almost all our aeronautics development capability in the U.S. In fact, if a company like Boeing wants to do qualification testing on a new aircraft design, they have to go to the Netherlands, because we don't have a wind tunnel here that's capable of doing that.

So, anyway, I'm encouraged by that movement, and I think it will restore some of the interest, and I think it will maybe restore some of the university capability in that area. At least the Department of Energy is pursuing some programs that aim at doing that. We've had some discussion—actually, I'm working on a group with the [A]AAS [Association for the Advancement of Science] that I got invited to work on, talking about how do you restore attention to civilian ground-based nuclear reactor power supplies. One of the issues there is restore technical capability among young people to get back into that business, which was a really booming one for a while. But it's totally dead at this point, so they don't go into it. And many of the test reactors at universities have been shut down and are being shut down, so students aren't really eager to go into that.

Same thing with the space business. How do you rebuild that? And we've got to.

RUSNAK: Did this current push for returning to these kinds of concepts come as a surprise to you?

FINGER: It did a little bit. Yes, I didn't know it was going to happen, but, to me, it was always inevitable that if we were going to have any deep-space science or human missions, we would have to go nuclear. Pluto proved that to a large extent. So there was never any question in my mind if NASA was going to have a major science exploration program, you'd have to go that route.

So, from that point of view, it didn't surprise me. It surprised me, if anything, that it happened that quickly and visibly. It wasn't snuck in somewhere; it was a visible point that was made. And Sean O'Keefe keeps emphasizing the need for technology development on power and propulsion so we have a capability to do missions we may want to do.

My sense of inadequacy in that is, I haven't yet seen the real definition of "So what, in fact, are the missions you're aiming at?" So you can development the technology, a technology base, but not one that's necessarily directly applicable in all those cases. And you may have to make some adjustment. That might take time. But at least let's get the technology rolling and maintain a strong technology [development] effort, but let's get to defining some of the missions more rigorously and fund them appropriately.

RUSNAK: How different is the technology now than the last time there was a serious effort?

FINGER: Oh, I don't think it's different.

RUSNAK: Really?

FINGER: I really don't think it's much different. I think much of the technology is going to be an extension of what was there and get back to it. I really believe that.

RUSNAK: So in forty years there's—in terms of that field—

FINGER: Very little was done. Really, very little was done. I saw a little bit of work in Russia. There's been some talk of using thermionics, and that's a study that I was involved in, but I don't see that giving any great benefit over thermoelectrics, which are more conventional, lower temperature operating systems, so I just think there'd be a greater tendency to use what's closer to available, at least to move us to a position where we know we have a capability to do some of those science missions, and then keep advancing the technology.

NASA, and certainly NACA, was a technology research and development organization. In NASA we always had the Office of Advanced Research and Technology, in addition to a vehicle development organization. Ray [Raymond L.] Bisplinghoff followed Ostrander as head of the Office of Advanced Research and Technology. So we had that advanced work. The work I did was in that Office of Advanced Research and Technology. We aimed generally at missions, not a specific one, but we looked at various alternative missions and worked technology for it. That's, I think, what we have to really be sure we emphasize, and I think that's what Sean O'Keefe is trying to do.

Under Dan [Daniel S.] Goldin, the interesting thing is technology was put with the mission, so the technology development work was done only to the extent of serving the mission need; therefore, it didn't necessarily go to a broader advanced look. I always had a criticism of that, even though I said, well, I want to be sure of it, and even today, when I say, "Okay, you want that advanced technology, but tell me what mission you want so at least you're assured you have some technology going toward that mission while you have a broader scope of advanced research." Maybe we ought to go back to an Office of Advanced Research and Technology. But you need to have some good feel for what you're aiming at so you can be sure something is pointed at that while you're doing the broader advanced work.

But previously the technology development was in the mission office. Well, what was the priority? The priority was clearly on getting the mission, not on the advanced research, and the advanced research suffered.

RUSNAK: It makes you wonder if they had kept that emphasis on advanced research where the technology in this field, particularly, would be now.

FINGER: Oh, absolutely. In my mind there's no question if we go back to the nuclear rocket program, we're going to go back to the materials we had, to the coatings we had, and all of that. We're going to start back there and go from there.

RUSNAK: You mentioned just now materials and coatings. Were those two of the key problems at the time?

FINGER: Oh, yes. Well, it's a pretty straightforward one, which is one of the reasons that there was some question about using tungsten. The fuel elements we had were graphite. Graphite and hydrogen interact, always. So you have to put a barrier in there between the graphite and the hydrogen, and a lot of work went into that, really solid work, and there were good systems developed that really protected the graphite over a very extended period.

On the other hand, the tungsten has a problem in that it produces an isotope that absorbs neutrons, so there's a negative to tungsten as well, even though from a tungsten-hydrogen interaction, it's really good. But the major tungsten isotope would absorb neutrons so you'd have to have a bigger reactor, and so on, maybe heavier, unless you separated out that isotope and went to enriched tungsten, which becomes a very costly process. That's one reason that tungsten wasn't necessarily the best.

The Lewis lab people, like Frank Rom and others, pushed tungsten, always, and kept pushing it. That's one of the elements that I was thinking of when I referred to Clinton Anderson being opposed to Lewis, because they were in competition, in his mind, with some of the work going on at Los Alamos, where they were working graphite.

So the materials went down to graphite particles with coatings on the particles, all compressed, with coatings on the fuel elements, and things like that, in the graphite. Both have problems. And maybe we can find other materials, but I think that's an area where there would be further progress made if work were reinitiated. I have no question about it, really.

Now, we had other advanced concepts. We had gas-core reactors, where you actually used the fuel within a gas system that was cycling circumferentially and contained within a reflector to get to very high temperatures and impulse, and we supported work like that. We supported a broad range of technology at that time.

So some progress was made on that, but I think that's nowhere near available for an actual mission, whereas the graphite systems are. They would be available to use, if we could [go] back to restoring the capability, the production capability, and everything else.

RUSNAK: It sounds like more than a few things need restoring in order for this program to actually go anywhere these days now.

FINGER: Oh, yes. Oh, yes.

RUSNAK: Along that line, you had made the point earlier that they need to define some missions for this now. What were some of the mission definitions that you were looking at back in the sixties?

FINGER: Well, there's no question. The one that's emphasized most for human … [exploration] is the Mars mission, and that's the one we were talking about heavily, Mars exploration. You get down to a point, though, where you have a real almost conflict between the science community and the community that says, "No, you have to develop a much broader capability that really demonstrates the very strong technology leadership and base in the U.S.," and that means talk about humans in space. Not only in a space station, but also in exploration. So that the things you don't anticipate you can examine, and so on.

Maybe build a base, maybe eventually get to the point that this Bob Zubrin keeps talking about, which is, "Sure, let's have people go to Mars and get fuel out of Mars to make hydrogen so you come back with a nuclear plant using that hydrogen." I say, that's real great. How do you build a hydrogen plant without humans? Do you take it there? How do you get it operating and check it and all that? So I'm very skeptical with him on that theme. Fundamentally, the concept is just great, but I don't see how you build that and get it going. Maybe I'm too practical on these things, I guess.

So I say, that's okay. Have humans go there with a round-trip capability to Mars orbit, have a nuclear system to bring them back to Earth orbit. But at least they go then and they can really determine what it is that the resources provide for you in Mars. You can do that. Actually, a lot of that can be done without humans, with various kinds of penetration systems and sample return systems, and so on. So you can do some of that. But eventually you're going to have to have somebody take some kind of a production system there and try it. How much of that can be done without humans? Maybe some. I mean, if that's the case, fine. Depends on what your time scale is, again. But eventually you're going to want to have humans go there. That's the whole reason for trying to get production there. So you're going to have to build a plant of some kind, and that's going to take time.

So there are a lot of issues like that, but Mars was the mission we talked about most for the thermal rocket.

I also think that you get faster trip time with a higher thrust system like a thermal rocket system than with an electric thruster, because getting high power is not real easy, high electric power, even in a reactor. You can use turbo generators, thermoelectrics, maybe eventually thermionics, but the thermionics are going to have to operate at very high temperatures to be effective, and I'm not sure what their life capacity would be if they're put within the reactor itself. So a lot of work would have to be done.

There is a report that I was involved with, with a team that wrote it. I will say the people who led it were people who had been involved with a Russian Topaz thermionics system, which was imported to the United States, but the only testing—and I saw that in Russia—it was pretty good work, but the system that came here only underwent nonnuclear testing, so it never got to the problems of materials compatibility with the fuel elements and all of that. So the program was finally killed. There was no real mission need for it.

So, again, at some point maybe some of that'll be restarted to see how we can make that operate. The report was put out probably a couple of years ago. Maybe not even a couple years, maybe just a year. I've got that here.

There are a lot of technologies that might come back once people really begin to look at nuclear applications and technology.

RUSNAK: First they have to figure out those applications and find the money to support them.

FINGER: Right. Right. But I agree with O'Keefe. You ought to have the technology program that's going, but I'm a little concerned that he's not really aiming at defining what missions are you really talking about. So the technology base is important and valuable, but at some point you have to identify the mission.

RUSNAK: One of the JSC people we talked to made the point that when it came to budget cutting, one of the first things to go were the programs that looked to the future rather than the present.

FINGER: Yes, that's right. Always. And that's a serious problem. I mean, it's hard for me to understand where the money will come from to restore the Space Station to a really usable space research center, which is what I've always referred to it as, the International Space Research Center. Like a ground center. That's what I'm thinking of up there.

But, gee, what is it going to take to prove that the system is credible and NASA is credible, again? Which is what the review group concluded was necessary. NASA lost its credibility, and I have to attribute a lot of that to Houston and the way it was operating. It really wasn't emphasizing, recognizing, or openly emphasizing the need for funding, because they were falling way behind in completing that system.

The second piece of it is that it concerns me that the international community is really being left out at this point. They put a lot of effort and a lot of work in, and, sure, some things are continuing, but fundamentally, I've heard nothing really addressing their needs and restoring any confidence on their part that they're still important to the program. As far as I can tell, it looks to me as if that won't happen until there's a decision to actually go ahead and try to beef up the crew capability.

I wish that when they said that there had been a commitment made, I still wish a commitment would be made that said, "Okay, we're going in, we're going to try to restore the credibility of NASA in this area; we're going to try to get the basic core concept completed. When we do that, we'll move ahead and increase the crew size." Commitment hasn't been made on that. So I worry about whether it will go at all, or will at some point somebody say, "No, let's not do it." I think it's important to do it.

I was never a major fan of the Space Station, figuring there's a lot of other stuff we have to look at, too. But having gone this far, I think we really ought to move forward with it and get research done in space, commercial as well as noncommercial.

RUSNAK: I think you'll find a lot of people in Houston agree with that, but I think it's at the higher levels that you need that kind of commitment in order to get the funding they need.

FINGER: It needs it. You see, I think it needs it at the leadership level. I mean, Sean O'Keefe came out of being deputy to Mitch [Mitchell E.] Daniels [Jr.] in OMB [Office of Management and Budget]. In his present role, I don't think he can be that. I think he's got to go in and say, "Look, to really do a job, here's what it takes, and in order to succeed, here's what it's going to take." So let's go with it. Don't just dream of the future, necessarily. Let's get some things done that we have now and develop the technology, pointing to potential future things that may have benefits. So you need a whole story in this thing, and you need that leadership.

Frankly, that's what I found in Glennan and Webb. I remember Jim Webb when Apollo was brought up. An estimate came in on the budget level. He almost doubled it when he went to the Bureau of the Budget. He boosted it. He said, "Look, I can't be sure of it any other way. I've got to go up to a larger figure. This is bare minimum." And he got it. And that's what it takes, I think. Not "How can I squeeze through?" If you want the mission to be done, then give me some assurance. Let me have margin because I'm not sure what I'm going to have to do. I don't find that leadership.

RUSNAK: I was just going to say those days seem like they were a long time ago now.

FINGER: They are. They really are. See, Dan Goldin didn't do that. He didn't go battle. He just accepted, and he accepted what he perceived would be approved, and then praised it. Well, so,

there's a four- or five billion-dollar overrun on the Space Station, and it's related. Instead of really going into battle for it. And here the U.S. was paying for such substantial part by the Russians, in addition.

RUSNAK: Paying for the substantial part that was supposed to make the rest of it cheaper.

FINGER: Yes, yes.

RUSNAK: You had the chance, after you'd been working on the nuclear program for a while, to move into a different sort of experience where you had an opportunity, I think, to change some things. Maybe you can talk a little bit about your role as the Associate Administrator.

FINGER: Well, it was interesting how I got into that, because, basically, the line Jim Webb gave—and these are words he used on me at least one time and more, I expect, well, one time certainly—"How can I make a technical man like you understand the importance of management?" And for some reason he decided he was going to move me into management. What the background of that was, I don't know. I guess he thought highly of me, and he named a few things that he would want to be included, and it was fundamentally all the management stuff—technology utilization, education, everything. And he said, "Do you have concern about that?"

And I said, "Yes, I do."

He said, "Why?"

I said, "Because you're so involved in those yourself. What role could I have in that?"

He said, "No, I want you to take it all."

See, he tested me first. He tested me first by pulling me out of the joint office job and my other jobs in NASA and AEC. I still retained the job in AEC on isotope power, but he asked me

to take a look at our delegations of authority, the statements that were issued on authorities of different elements of our organization, and various times those changed. So, okay, a new delegation came out giving authority to somebody.

How that matched with the Space Act itself and the authorities assigned in the Space Act, the first thing I came to was the conclusion—and I remember giving it at one of the luncheons we had—he asked me, "Well, where do you stand?"

I said, "Look, one thing is very obvious. So many of the delegations of authorities fail to recognize that the total authority for the agency's activities are given to the Administrator. So authorities and delegations are assigned without recognizing that it's the Administrator that has the authority." It was almost like he was looking for that, because that was a reinforcement of the role of the Administrator, if anything. So we started from that.

Then various other things, and that's when he came up with the idea of making me head—or he must have had that idea before, or otherwise why would he have assigned me that function. So I moved into that role with all of the personnel office, contracting, all the other things came under me—technology utilization, education programs—and I also had to be in a position to approve program plans produced by the program offices. I had to go through and give approval of those, raise questions, and so on. That had not actually been done in the administrative side of things before that, because they were kind of fragmented. There was a head of administration, but not the same role. I just got started doing it, is all I can tell you, and relying heavily on the people who were already there, although there was a small group that was more direct staff to me to bring information in.

One of the early questions I had was related to communication requiring all administrative actions being brought centrally, from out in the field, for approval. And I raised—well, it wasn't quite that, it was also computerized information, and, therefore, needing new computers and things like that. I said, "How many times have you actually had a feedback that indicated there was some problem?" It turned out, very few. So I said, "So you mean to say

after you did all that, the thing just died?" And, sure enough, that's what happened, so in many cases there was no real need for it. And the test of time proved there was no need, so we didn't do some of those things that were included within it. We cut out some of the administrative oversight function and so on, but instituted some others, including this program review role that became very significant. So when George Mueller wanted to move out on some new concept, you know, yes, we had to look at it, and, to some extent, I have to say, I had to look at it.

I haven't thought a lot about that recently, but I did have to do that kind of thing, and it was interesting and a real challenge to me. I remember when I was brought up to become a fellow of the National Academy of Public Administration, which Jim Webb really stimulated.

[Tape recorder turned off.]

RUSNAK: Talking about being the AA for Organization and Administration. Initially it seems your route into this was through Webb putting you on a preliminary study, and then after that they decided to make this a permanent office, and you got through that.

FINGER: He did. He really did that. And I think you have to recognize the emphasis he had on management.

Let me go back to the establishment of the National Academy of Public Administration. He became president of the American Society for Public Administration. I think that was it. I've gotten this roundabout in various ways. Apparently at one of the meetings of the board of that group, which is an existing group, American Society for Public Administration, [Jim Webb] said he thinks the public administration field needs the same kind of elite recognition that's in the National Academy of Sciences, and therefore, he proposes establishing a National Academy of Public Administration. And I got indication that some of the people objected to that. And he

said, "Well, if that's the way you feel—," and I understand he closed the books and started leaving, saying, in effect, "Forget it. I'm not the one."

But that was what stimulated the National Academy of Public Administration, and it was then presented and chartered by the Congress, so it's like the National Academy of Sciences from that point of view. And he has pursued that ever since. He was basically the founder of the National Academy of Public Administration. And that was while he was still in NASA, still active in NASA.

I've become a fellow of that, and so on. I remember giving one talk to that ASPA group, saying, "You know, I never really thought of myself as a public administrator, even though I was running projects and doing work for the government," you know? That kind of thing. And I'm very involved with that organization on a variety of studies, and I find it stimulating, and it keeps me very busy. There's a meeting tomorrow morning on an executive organization and management panel, standing panel. Next week there's another meeting of a panel on human resources, public service capability. There's a social equity panel, which I haven't been very active in, but it's also a significant one. So I stay very involved with that. In fact, we're going down to an annual meeting that they're having this year down in Charlottesville at the Boar's Head Inn to talk about basically new technology in public management and administration. That's one of the elements of it, and we'll be there for two, three days.

Then we'll go down to another meeting down in Hollywood, Florida, which there is a dual purpose for that. Arlene's mother lives down in Hollywood, Florida. This meeting is a meeting of the American Nuclear Society, and it's going to go over really examining the future of nuclear power plants and so on, new power plants. So I'm still involved in things like that in various ways.

Tonight I'm actually going down to a meeting at the national Air and Space Museum. A fellow by the name of Mike … [Neufeld] there has discussion groups, oh, I would say, roughly, every month or so, something like that. Today there's somebody coming in presenting a story

about General [Leslie] Groves, the leader of the whole nuclear rocket development program. I don't know what this speaker's background is in relation to that, but apparently he's done some research on it. I expect I may run into some disagreement with him, not on Groves or anything, but he's also at the Natural Resources Defense Council, which opposes nuclear energy use, which is an anomaly to me, so how's he going to present Groves' stuff? [Laughter] So we'll see.

So I stay involved in all those things. I'm very involved in the energy areas, and, of course, as president of the NASA Alumni League, I still … [am] involved there.

RUSNAK: How did you feel about making the move to something like technical program management, like on nuclear rockets, to this more public administration?

FINGER: I had no trouble making it. I didn't feel anything. It was a very broad-scope responsibility, and that concerned me to the point that I wanted to be sure I really had solid people in each of those areas, but that's what I always treated anyway. I wanted to know, you know, if I had a safety issue to handle in nuclear propulsion, that I had somebody of … [stature], of capability, in the safety area to really do comprehensive examination, or at least to be able to be discerning enough to pull responsible people together to examine it. Or if there was an issue on testing and some of the technology, I wanted to be sure I always had capability.

And that's the same thing that applied here. So I handled the budget and the personnel and, as I mentioned, the contracting and the technology utilization programs and various of those. But in each case, I had very strong people in those areas. And it was a matter of consolidating those activities. And in many cases you had to get several of them working together to really do a sound evaluation. It couldn't be done just as an individual. I mean, there had to be team pull on all of that. And that's the way we did it.

But there, there's no question, my reporting was very directly to the Administrator, so I was very involved in most of that work. I guess that's where that picture came from. That's why I was up in that office, right there, the Administrator's office.

RUSNAK: There's been some suggestion that the creation of this office at least had some political aspect on the part of Webb to kind of reorganize how the reporting and the power structure, I guess, within NASA Headquarters was working. I was wondering what your thoughts on that were.

FINGER: Well, I think there's probably some truth to that. [But not the main reason.] The fact that I was put into a situation where if you had the key program leaders, AAs, Associate Administrators, coming in with plans that this administrative office would have to examine, that we would have to review and comment on. It was a reflection of dividing authority, or bringing others into the decision process that was not necessarily being done up to that time, and being done on, you might say, an equal footing. There's no question about that.

The general counsel's office, obviously, also always had a role, but management didn't necessarily. So I think by raising that, he added another factor in the evaluation of program plans and concepts.

To tell you the truth, I can't say that I ever really thought of that that way, but I recognize that that is the situation. I don't know if that was his intent, but certainly by making that assignment he put me in the line of approval. He put the administrative office in the line of approval of, are there problems that come up in any of this? Are there things you have to be cautious about? Can you, in fact, implement based on this? And so on. And we had to look at it on that basis. And, in fact, our review and approval was required on each of those situations. I don't have any hard records that I've pulled out in that area. They're harder to pull out because they were very diverse in most situations.

But, yes, that's there. For example, I got heavily involved in the issue of contracting out various functions, and I remember I really got—well, I got crosswise with a congressman from, I think, Virginia, Porter Hardy [Jr.]. I think it was Virginia or Georgia. I'm not sure which. Porter Hardy, who was dead set against having any contractor brought in for management functions. Really hard.

I had to defend some of the actions we took, but we had a clear concept at that time, and that was, you don't give away fundamental decision process in that area. It's more a mechanical check, more a routine check. There was a provision in the Bureau of the Budget called A-76, that said, what is an inherently government function? Incidentally, that's not used hardly at all today. We had to examine contracts on the basis of that, so you couldn't give away really fundamental decision processes that had to be made by government.

And maybe that's partly what's instilled within me, this concern about assuring an in-house capability in any area, because you never relinquish your responsibility for implementation of whatever it is that's done. You can give away a piece, but, heck, don't give away a fundamental decision process to a contractor. Some of that's been done. I mean, I look at some of the space mission positions where they're out, basically, with a contractor. United [Space Alliance (USA)] is running a major mission. Is running the mission. What is NASA's role in it? What is the responsibility of NASA people in it? Much harder to tell. So I think there was an element of that in that assignment. I think that's the reason for that.

He also, I think, wanted to re-enforce the authority of the Administrator in all such decisions, and even with the key program people. Sure, discuss it and everything else, but we've got to have an administrative review of it across the board.

RUSNAK: What effect did the Apollo 1 fire have on these kinds of decisions?

FINGER: Well, I sat in on all those meetings. There's no question about it. I can't say that it changed things. It was just a major problem that we faced, and the Administrator was on top of it all the way, as were others. Bob [Robert C.] Seamans was heavily involved, people down at Langley were involved, a committee was set up to examine, and so on. But I can't say that it really affected how I worked. I was involved in it. I sat in on those groups, but I can't say I was a decision maker in that process. I haven't thought about it. I really haven't.

RUSNAK: I just didn't know if that incident had brought to light any of these organizational concerns that were addressed by the creation of your office.

FINGER: I don't think so, really. Well, maybe it had some role, but I don't know. I really don't know. I never had that feeling that it was that that stimulated stuff.

RUSNAK: You ended up staying in this position as AA for a couple of years.

FINGER: That's right.

RUSNAK: Why did you decide to leave that post?

FINGER: Well, because I had a call about five o'clock one afternoon from the new undersecretary of HUD, asking me to come over and talk to the Secretary about joining them. It was the '67 period, wasn't it?

RUSNAK: 1967 to 1969, I think, is when you were the AA.

FINGER: Yes. It was in … [‘67] that I got the call to come over and talk to the new secretary of HUD, George Romney. I didn’t know him. I didn’t know the undersecretary, Dick Van Duesen, and I said, “I’m really thinking about leaving government,” and, in fact, I had explored a couple of possibilities. One was to go to Westinghouse and maybe head all the international activities at Westinghouse. There was another one to—well, not General Electric, but another company, but the principal—I was thinking of leaving government.

I got this call, and it was during that period of turmoil in the cities—riots, real problems—we discussed major issues related to just normal living in the cities, L.A., Chicago, and so on. I got the call, and they talked about two different jobs, one to head all the administrative functions in HUD, or to head all the research, and they were going to establish a new position of assistant secretary for research and technology. For research; they didn’t have a hard concept of it. And which would I prefer? And I said, “Well, I think I’d lean to the research one, but I can’t say that I’m really experienced in these areas.”

And they said, “Well, look, that’s okay. You’ve done a variety of work.” So I asked if I could just think about it a while.

They said, “Sure. Call us back.”

Well, I realized right then they never asked me my political affiliation. Didn’t ask. And I’ve told this to a couple of people, but not too many.

The next morning I called this Dick Van Duesen, the undersecretary, and I said, “Look, in case I decide I do want to come over, I don’t want things to get spoiled because you didn’t ask me some questions that may be significant.”

He said, “Like what?”

I said, “Well, neither you nor the secretary asked me anything about my political affiliation.”

And they said, “Well, what? What’s the problem there?”

And I said, “Well, I’ve always been registered as a Democrat.”

He said, "Where?"

I said, "Maryland."

He said, "It doesn't matter." It just didn't matter.

I ended up deciding that—by the way, there were a lot of changes that had been made in NASA I should point out, while I was there, in the way things were run, the way presentations were made, the way program proposals were made, program plans, and so on. A lot of that. A lot. And I decided, well, okay, maybe this is a good time to make a change, and I'm interested in some of these areas, some of the social questions, and so on. So I decided to take that, the research side. And that's just the way it happened. It came out of the blue.

I really don't know how they learned of me. I have a hunch that I've never checked out, that one of the people that had worked in AEC, who had also worked in HUD and handled some of the administrative functions, although not the totality of it, may have suggested me, and I've never specifically asked him that question. He never volunteered it, so I figured, "Okay, I won't ask him." And I see him even now. So I have a feeling it may have come from there that word got out, but he left HUD about that time and went to Bureau of the Budget, I think, and he was in government a long time after that. He went someplace else. So I decided to take that job.

RUSNAK: Do you have any regrets leaving NASA?

FINGER: Oh, no, not a bit. It produced a much broader range of activity. I had never lost my connection with NASA and its people and the programs I was involved in, but there were new opportunities, new interests that came up with it, new technology areas, major new programs on the social side as well as the technology side, and I really am delighted that I made that move. I should say, of course, from there it was still the NASA connection that got me to GE, because it was Tom Paine in NASA who went to GE and asked me to come to GE.

RUSNAK: By the time you had left NASA, had your style of management or your basic principles changed since you first start managing people there?

FINGER: Gee, I don't think so. I don't know that they've ever changed. [Laughs] I really don't. I honestly don't. I think I'm being honest in saying no, I've had the same perspective. You work with a team, with everybody. Everybody's got to have a role in the operation, and that I've encouraged that. I've always worked it that way. That's kind of a theme, and you want to get really good people who have a real capability in those functions.

Incidentally, when I went to HUD, one of the first things I did when we got to talking building technology and so on—well, before that even, when I was in the AEC. When I took over the AEC isotope power job, when I had the three jobs, in AEC, a joint office, and NASA, the AEC job, I wanted an organization that would help me on the isotope power development, and I went to Sandia [National Laboratory] and got a group set up there to be an arm of mine in the technology of isotope power units. The same concept that I'd gone along with all along.

When I came to HUD, I looked for a building technology capability, and it turned out the National Bureau of Standards, now the National Institute of Standards and Technology, had some people who had worked on building technology, and I set up an office there to serve as an arm of mine, because one of the things we went to work on in HUD very early was what was called Operation Breakthrough, a major program to develop new technology, new production methods, for housing, to try to reduce the core costs and improve quality. And I needed capability in that area. I actually lined up with some of the unions as well in that process. In fact, we had major meetings with the unions talking about that Operation Breakthrough.

Now, Operation Breakthrough had technology elements as well as building sample communities of mixed income housing, trying to provide a social mix of people in sample communities. So here I was again, technology and the social issues very significantly there. We

built several sample communities around the United States, in Michigan, near Atlanta, in Georgia. We tried to build one in California—Sacramento—Phoenix [Arizona], various places.

We tried to build one in Delaware, New Castle, Delaware, and the governor had proposed a site. We got proposals from various locations. The governor proposed a site. When we picked it, there was an uproar in that community. Automatically, if it was government coming in, it had to be public housing. They didn't want public housing. So we finally backed out of that site.

While I'm talking to you, I'm thinking, did we ever build one in Houston? I can't recall. I'll have to check that. I can't recall. It's out of my head right now. [No we did not]

But anyway, so we moved forward on that kind of a program and I had to build an organization, and the way I built it was the same way I'd built it before, looking for technical arms in those areas wherever I could find it.

The last thing I started was a program called Housing Allowance Experimental Program. One of the issues was, are we better off building housing for the poor, or giving them money to improve their housing situation. So we started this program, Housing Allowance Experimental Program, where, in sample communities, we gave people money and tried to measure what did they do with the money. Who would manage such a program? We had local housing authorities or other government groups within the cities or states. And would it generate new housing construction on its own?

The interesting thing is—I left probably two years after that, a year or two after that program got started—the program ran for ten years, with detailed data evaluation all along the way, and it became the base for a major housing program called the Section VIII program, where they provide vouchers or certificates. Certificates, you can use the money given on a certificate in a particular housing unit that they've previously approved as acceptable. So it is a boon to a developer who wants to have some assurance of the income. A voucher is one that people can use it any way they want. Things like that.

There was a whole variety of things that we worked on in that program, but one of the elements was developing new technology. And, again, as I mentioned, we built sample communities with a mixture of technologies, but with that also a mixture of social makeup in the area to see how it would work.

I keep saying, one of these days—I haven't done it—I'd like to go back and visit each of those sites to see how they're operating, contrasted with the problems that were very apparent then in public housing, which were really serious.

In fact, at that time we were destroying public housing, like out in St. Louis, the Pruitt-Igoe Project, we destroyed because it was a total social failure, with criminal acts and so on. I remember being out there once and I was being led around the area, and as we passed the entrance to the [unclear], I said, "Wait a minute. Let's not go by here. Let's go in there."

The guy who was escorting me said, "We're not going in there without an armed guard." In public housing. High-rise public housing. Things like that.

And in Chicago? Awful. And yet Chicago's a city made up of such a mixture of people and uses and everything. I don't know. There's some of that, I expect, still exists, but some day I may—I keep saying I'd like to go back and revisit the sites. I'll have to look it all up and see if Houston is on the list of one of the sites. It was that kind of a variety of things.

I, by the way, kept Tom [Thomas O.] Paine involved. I even kept Jim Webb involved in some of the things I was working on and considering.

I goofed one time, seriously, because one of the Appropriations Committee chairmen proposed a site for Operation Breakthrough, and instead of his site, we selected another one in his state, and somehow in the press release I emphasized that site, the competitive site. Well, he wanted to eliminate the whole budget as a result.

So I talked to Jim Webb and I said, "Look, can I go to the chairman of the whole committee and indicate that this is a problem?"

And he said, "I'll tell you, Harry, I know the chairman. I'll just mention it to him."

And I said, "I think I want to send a letter to this congressman to apologize for what I did."

He said, "That'll only hurt you more."

I went to him for advice, and we ended up getting the money we needed for the program, for the one site anyway.

Okay. Anything else on that?

RUSNAK: Actually, I think we've covered most of the topics that I had brought with us. We're getting close to the end of this tape, but I don't know if there's anything else you want to talk about before we wrap it up today.

FINGER: Well, the one thing is the move to GE, because that was a dramatic one, and very important for me in getting into a whole area of energy use. It came shortly before the major oil crisis grew, where I was told to head a utility engineering operation in Schenectady, as well as setting up a center for energy systems, to really do energy studies, with GE feeling that was an important area.

Reg [Reginald] Jones was the chairman at that time, and Tom Paine headed the utilities side of the business, and so he brought me to GE, and I went with that and I was really very happy about that.

Shortly after that, he made me the—well, there was another person who came in, and I was made the head of strategic planning for the utility business, and continued for some time in that role. And I have to say, if we have this apartment, it's because I went to GE.

Then from there, partly because of people I had met in the energy business, I was asked to come to head a new organization on informing the public on energy systems and specifically nuclear energy power plants and their benefits, and trying to stimulate investment in nuclear energy power plants. That was the U.S. Council for Energy Awareness, which I stayed in for

quite a while and, I think, did very well there, as well with major international interfaces in the energy area, and that's what got me heavily into the energy business generally.

So it was a broad scope of things. Fundamentally, I still stayed involved in all of those things that I ever worked on, in various ways. I try to stay informed on them, but I have to say it gets damned tough when you're not really directly working on it, so it's a matter of reading as much as possible, going to meetings, and going to hearings up on the Hill frequently.

For example, this morning there was one that was postponed from the fourteenth to today on the waste site, Yucca Mountain Waste Site, which I'm very interested in and involved in to some degree in evaluation and so on. So I stick with all those things. Yes, it's been fabulous being in all these things.

RUSNAK: You've certainly had an interesting variety of areas to cover of subject matter. It's amazing.

FINGER: It is. It really is. I can't say what is my primary role. I have difficulty saying that. It's being involved in major issues that confront us in many ways, and that's the way I view it as well as just talking very strongly about the benefits of the space program, which is not one of those major issues that confronts us. Energy is. Housing and community development issues are, and so on. And broad public management I think is a big issue. Space, to me it's very important, so I want to stick with that and be involved.

RUSNAK: My tape's about to run out, so we at least need to stop here for a second.

FINGER: Okay.

[End of interview]