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EDITED ORAL HISTORY TRANSCRIPT

LENNARD A. FISK
INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is September 9th, 2010. This interview is being conducted with Dr. Lennard Fisk in Ann Arbor, Michigan. This is part two. Yesterday we visited with Dr. Fisk as well in his office at the University of Michigan. This is for the NASA Headquarters Oral History Project. The interviewer is Rebecca Wright, assisted by Jennifer Ross-Nazzal. Thanks again for finding time in your schedule for us.

Yesterday we visited about some experiences that you had early on in your career and left off talking about when you were still Associate Administrator for Space Science, talking about strategies and how important strategic plans were. In fact I borrowed one that you had loaned me. You had a number of them. One of the areas that I thought was very interesting that you had talked about, that strategy is constructed around five actions. Establishing a set of themes, a set of decision rules, a set of priorities for missions and programs within each theme, and to demonstrate that that strategy can yield a viable program, and then check the strategy for consistency with resource constraints. Just from our talk yesterday I would have to think that number five was sometimes a little bit of a challenge, that you had resource constraints about budgets. Can you share with us how the budgets impacted the strategies each year and how you were able to adjust for those?

FISK: Remember, that's 1988. So you are still in the period when the NASA budget was just rising. It doubled in those years. It's after [Space Shuttle] *Challenger* [STS 51-L accident], and

the country basically said NASA, we want to get you back on your feet as quickly as possible. Congress did something, it was almost amazing that they did it. They bought the replacement orbiter in one appropriation. Just $2 billion, here it is, buy an orbiter. None of that happened after the [Space Shuttle] *Columbia* [STS-107] accident. NASA was left to its own devices after *Columbia*. But after *Challenger* the agency was well supported.

So in the beginning of the strategic plans, it was not really resource constrained. Obviously there was always more that you would want to do than you could do. But one of the themes of the early strategic plans was to demonstrate that we were back on our feet again and that the nation had a viable space program. So it was possible to sell large new starts. So for that plan I believe, the new start would have been AXAF [Advanced X-ray Astrophysics Facility], which is now the Chandra Great Observatory. Then the next year it was CRAF [Comet Rendezvous Asteroid Flyby]/Cassini. Then the year after that it was Mission to Planet Earth and the big EOS [Earth Observing System] program.

At the same time we were able to sell Small Explorer programs, other enhancements of the budgets besides these major new starts. So it was a time to be successful from a budget standpoint.

When you get into the plans though of the early ’90s then you see this change in the whole landscape of NASA at that point, because it’s the end of the [President George H. W.] Bush administration. Economy is not doing well. President says read my lips, no new taxes. You end up in a period of very constrained budgets. They were constrained more than we had anticipated. Because whenever you start a new program, there are these multiple years of funding that you expect. So if you added all that up you would have had a program that was going to grow steadily each year. It wasn’t an outrageous growth. It was one that was approved

by the Office of Management and Budget [OMB]. It wasn't as if we were hoping for something that no one said we could ever have. But the landscape changed and suddenly there was none of this growth there. Then the plans had to adjust. They had to adjust in a way that you could no longer sell new big things, it was just out of the question. We were having to descope what we had. AXAF got descoped. We lost CRAF. We descoped Cassini, descoped Mission to Planet Earth and EOS. But putting anything big in the budget at that point was not possible.

But then the plans knew what to do with that. They said okay, it's no longer possible to sell big things, so we'll sell little things. That's where you get programs like Discovery, which are the relatively small planetary missions. Planetary missions are always expensive. But relatively speaking the Discovery program, which has been very successful for sending relatively small planetary missions out, starts at that time, because that was all we could imagine that we could afford in this constrained budget. You always want to put something new in it if you can. But at the same time you're having to adjust to the fact that you don't have the resources we expected to have.

WRIGHT: We use the word sell. But what does that exactly mean from the position you were in?

FISK: Well, any time you want to start a new program—at this time in NASA everything within science was bottom-up. The National Academy of Sciences has a variety of major committees that do decadals and plannings and so forth for each mission. For each of the disciplines within NASA. So you wanted to have the support of the science community as measured by those academy reports as the basis for what you were putting forward. Then the division directors within each division would have things they wanted to get on behalf of their community. So

they then sold to me, convinced me that I should try and get this in the budget somehow. Then I had to sell that to the [NASA] Administrator to get it into the NASA budget submit to the Office of Management and Budget. Then it had to be approved by OMB and be put in the President's budget, and then it had to eventually get approved by Congress.

They're known as new starts. The idea was to get a new start. So there are all these steps in the process working from something which is a community initiative up through internal NASA Headquarters, over to OMB, over to Congress. Congress was very seldom the problem, because, as we talked yesterday, the famous 20 percent rule was in effect—that 20 percent of the NASA budget was supposed to go to science. So long as I kept my requests within that 20 percent number, it was generally fairly easy to get approval. Almost all up and down the line. If I'd tried to get too far out of the 20 percent, the agency would probably have objected. They would have said no, we're not going to ask for all this for just science, because that'll come out of human spaceflight. Congress looked at that number.

In fact [James C.] Fletcher when he was the Administrator was so convinced that Congress would give me the 20 percent that he often would only allow me to propose about 18 or 19 percent, because he was sure that I was going to get it anyway. He wasn't going to ask for anywhere near the 20, certainly not more than 20 percent. So that 20 percent rule, which had its origins, as we talked yesterday, in this deal between the science community and NASA on the Space Station, it was an amazingly useful device for scaling what the resources were going to be to use within the strategic plan.

WRIGHT: I know that you came to work for NASA in your position under Fletcher. But then a couple years or maybe within the two years, it changed, and Admiral [Richard H.] Truly came in. Did it change for you under that Administrator?

FISK: It didn't. There was no change. Truly had been the Associate Administrator for Human Spaceflight at that point, Code M, under Fletcher. So he and I had worked together before. NASA still ran at that point with the idea that the science community takes care of itself, that planning is bottom-up, the organization will screen the programs that are going to have to be sold, and you have to sell them to the Administrator to get in the budget. But there was a lot of deference given to the science community for what it is they want. We were considered to be a well run organization.

So we were believed if we said this is what it's going to cost and various other things. So I didn't notice any change. I was well supported by Fletcher and by Truly. We ran just smoothly really. Those in many ways were our best years, because we were still in this upswing on the budget. But things changed then in the early '90s in lots of different ways.

WRIGHT: You mentioned the International Space Station. Of course when *Challenger* went down then the launch vehicle for the space area was affected. Could you talk some about how those two programs impacted either for or against or both on how the space sciences programs were administered?

FISK: It's a somewhat complicated story that goes with this. Because of the 20 percent rule, science benefited if someone were to fund the Space Station, because that basically allowed the

whole NASA budget to go up, and science benefited from that. At the same time of course the *Challenger* accident left us with this huge backlog of very expensive missions sitting on the ground while we had to wait to fly off when the Shuttle started flying again, because everything had been designed for the Shuttle. That was the NASA rule of the early ’80s. We’re going to phase out expendable launch vehicles. We’re going to design all our payloads to fly on the Shuttle. So you didn’t want to reconfigure things when they were all finished to go on something else.

But after *Challenger* the policy changed—so that the Shuttle was not to be the only launch vehicle. The DoD [Department of Defense] of course ran for cover right away and said we’re going to go start up our Titan lines and everything else. So the American launch industry was allowed to be developed, and science was allowed to put its payloads on expendable launch vehicles. So things that had not started or could be developed or were mainly developed after the *Challenger* accident, they could be configured for expandable launch vehicles. Everything else had to still be launched on the Shuttle.

With regard to Space Station, the space science organization at that point was responsible for life science and microgravity. We had it all. We had Earth science, astrophysics, planetary, Sun-Earth connections as it was called back then, and life science and microgravity. We were obligated, if you like, to fill up the Space Station. We had some pressure on us to do attached payloads on the Space Station as well. But we fought that off, because it’s not the best way to do the science, it’s not the most cost-effective way to do the science. Free-flying satellites is the way to do the science. The Space Station is actually a bad place to do astronomical observations, for example. Debris is around the Space Station. Stuff comes off it, contaminates instruments. There’s a variety of bad things that happen.

But the stuff that you do inside, which we always referred to as the indoor sports, life science and microgravity, it is the place to do it. It's what that community had hoped to realize. So we had a program that led to that, Spacelab. The use of Spacelab on the back of the Shuttle to do various kinds of research for the duration of a Shuttle mission. Microgravity and life science for the interval that the Shuttle could be up. I think it's 20 days or something like that. There are some relatively long duration Shuttle flights. But of course the ultimate aim was to go to the Space Station, use the Space Station.

NASA has often had trouble figuring out how to interact with the life science and microgravity communities. The difficulty is that parts of the human spaceflight program treat life science as an internal event. But the science organization is all connected to the external community out there. In life science and microgravity, the best and the brightest in the country do not work for NASA, or even necessarily think about NASA. Think about life science research, well, you have the whole NIH [National Institutes of Health], and they are busy. Some of the best and the brightest are off doing medical research on behalf of humanity, that sort of thing. One of the things that we could do in the science organization, because we were recognized scientists, was to get these people involved in NASA's program. They wouldn't naturally go interact with Johnson Space Center [Houston, Texas, JSC], because that was considered to be a captive not necessarily peer-reviewed scientific activity. But we introduced the peer review process to life science and microgravity because that's the way we normally did business.

You select payloads based on their merit as viewed by the entire science community. So one of our tasks was also to cultivate those people. To get them involved in NASA, make them feel that this was a legitimate science activity that was worth their time to do, given that they had

other choices of things that they could do. They could work for the NIH, the NSF [National Science Foundation], the Department of Defense. There's lots of money out there in those fields for the best and the brightest in the country. We were trying to get them to come play with NASA, and we were the interface. In some ways we were the best possible interface, because we were all card-carrying scientists and recognized for our own scientific accomplishments.

So the Space Station was to be filled up. We had payloads under development to fill it up. We should at some point talk about where that whole thing is today. But at that time there were plans for the full utilization of the Space Station racks and experiments and scientists who were going to do it. It was like every other NASA program, they could think of a lot more things to do that you could actually afford to do, but nonetheless it was well expected that the Space Station would be utilized.

Now the Space Station wasn't developing very rapidly. There was design study after design study and so on. But the community was preparing to use it in a constructive way and taking advantage of Spacelab before the Space Station came into existence.

WRIGHT: You mentioned the Department of Defense. How were they involved with you with the science programs, especially those that were Earth-observing?

FISK: Very little. Like anybody in one of those jobs, you have the clearances necessary to talk to them. But I made a studied attempt not to talk to them. Because I always felt I don't want to even know any secrets that I don't need to know and have to remember that I know, that sort of thing. So we didn't have a tremendous amount of interaction. The big interaction took place at Hubble [Space Telescope] when the Hubble mirror went bad. This is hardly a national secret.

The Hubble Space Telescope looks just like the spy satellites except it looks the other direction. You say how do you know that. Well, it was built by Lockheed, who built the spy satellite. It was designed to fly in the Shuttle bay, which is where at that time they were launching the spy satellites from and so on. So I can't say I've ever seen a spy satellite, but it's not a stretch of the imagination to imagine that one looks up, one looks down.

But the Hubble had of course a lot of other things that were required of it. Its fine guidance sensors to be able to point at a star and hold it for a long period of time and other things like that.

But the obvious question that was asked was why didn't we test the Hubble mirror like they do for spy satellites? The mirror was built by the same company that built the mirrors for spy satellites. How come you guys didn't do what the spy satellites did? They tested their systems, and would have discovered the spherical aberration in Hubble, and so why didn't NASA do that? That was the question. Of course you had to go into a classified briefing and classified discussions to say why we didn't do what the other guys did. There are good reasons. Those are not classified reasons. Hubble works in the ultraviolet. So if you get one molecule thickness of contamination on the mirror it's blind in the ultraviolet.

So you don't do any tests that you don't have to do, you don't handle it if you don't need to. Hubble unlike the spy satellites looks at infinity. It's looking at objects very far out. So you have to build a device, an optical flat, to shine on the mirror, to know that you're properly focused. You have to create the equivalent of an object at infinity in order to test the mirror. If you're only doing it 200 miles away as with spy satellites, that's a lot easier. If you're trying to do it at infinity it's very hard. So the flatness of the device that you were using for your signal

had to be built to an accuracy that nothing else had ever been built to. So in some ways the test is very difficult because the test equipment has to be built to a standard that's never been built.

You may just be simply measuring how effectively you built the test stand rather than how effectively you made the mirror. So the decision was made. It was not my decision. Again the Hubble was all buttoned up by the time I got there. But they made what probably is the same decision I would have made, which is this is not the worth the risk, and we won't learn what it is we need to know, because it's going to be very sensitive to the test stand that you have to use.

The sad part about Hubble was by optical standards the mirror was so bad that Galileo [Renaissance-era astronomer] using what is known as a knife test would have found it. If Galileo were still alive after 400 years—he made the first telescope—and he held up his little knife test to test whether the mirror was the proper shape, he would have been able to see the distortion. Because even though it's—what is it? A fraction of a human hair. By optical standards, it was a bad thing. But nobody thought they were testing for a bad thing. They thought they were testing to the precision that the spec [specification] had said that they were trying to achieve. That was something that you actually couldn't realistically test for.

The classified interactions on Hubble were with the National Reconnaissance Office [NRO], in classified hearings. The National Reconnaissance Office is an unclassified thing now. It was not an unclassified thing when I was there. I can't remember which side of Hubble that was on. But the existence of the National Reconnaissance Office was classified when I first went to NASA and by the time I left they decided to admit that the nation actually had spy satellites, which everybody knew anyway. There was an assistant secretary of the Air Force who was in charge of the NRO and he and I had some classified hearings. So that was the main interaction on the classified side.

On the Earth science side there was not a lot. There was a project which started after I left NASA known as Project Medusa which was an effort to see whether or not any of the data that's collected by the CIA [Central Intelligence Agency] had relevance for Earth science. That was a classified activity, but that was after I left.

WRIGHT: Before you left the Shuttle program returned to flight, and before you left Magellan was launched as the first project. Talk about that time period. Did you have any hesitancy? Or was it mostly anticipation of knowing that it was going to be released by the Shuttle?

FISK: Oh, I had no hesitation about the Shuttle. We set Magellan on fire just about three months before we were delivering it to the launch pad. That gave me some pause. Magellan is one of the great stories about quality control, because during the construction of the Magellan spacecraft there was a technician who was working on it that was assembling part of the system, and the usual quality assurance guys were standing around, people were signing forms, everything was hunky-dory. The guy goes home, wakes up in the middle of the night, said I didn't do it right.

Comes in the next morning, says I didn't do that right. They said oh, everybody signed the form, we're working 24/7 to make the launch, we've already put thermal blankets on top of what you did. The guy said I didn't do it right.

They finally tore it apart. He had not done it right. It was not something you could have tested for. It was a mechanical hookup, and it was the motor that would have let Magellan stop at Venus and it wouldn't have worked. We wouldn't have discovered that until we got to Venus and kept right on going.

My thought was fire the QA [quality assurance] guys and monitor the sleep patterns of all the technicians. That may be the better way to maintain quality control. So there were a lot of issues about getting Magellan ready for flight.

When it was ready to launch, the Shuttle had launched a couple times by that point. Safety was not the issue. We had a grand time doing this. This became an odd phrase after Dan [Daniel S.] Goldin became the Administrator. But this was known as the second golden age of space science, because we had this great deal of activity in space science in the ’60s when NASA had lots of money and they were launching things all over the place in the science program as well, and then in the ’70s it dribbled off, in the ’80s you had this terrible dearth, because the Shuttle was under development, everything had to fly on the Shuttle, and the Shuttle goes down. There’s this huge gap in launches. Then when we started to fly again with Magellan, big blip. We’re going to launch Magellan and Galileo and Hubble and Ulysses. The list goes on and on. We’re having a wonderful time.

So we labeled this for the public relations effect the second golden age of space science. When we went to the Cape [Canaveral, Florida] to launch Magellan, my family came down, my three sons took the train down with my wife to Florida. I gave the pep talk. This is going to be the second golden age of space science. We had people there, and of course we got to t minus 31 and it didn’t go anyplace. It showed no signs of going for—it was almost a week I think before whatever was the matter with the Shuttle got fixed—so my kids were riding in the elevator, and somebody said, “Second golden age of space science. Bah.” So there was a lesson for me. This is always an important decision. How much do you hype what it is you’re doing?

Of course it came to roost when we hyped Hubble so much and then there was the big disaster of the mirror. Shortly after Hubble we launched the Gamma Ray Observatory, and I was

so burned by the Hubble experience of overhyping, we took the attitude maybe it'll work, maybe it won't, we didn't hype it at all. But the consequence is very few people remember the Gamma Ray Observatory. The scientists know about it, but the public didn't really notice that we had this very major Gamma Ray Observatory in the sky. So the hype is necessary to get people interested in the fact that you're doing this. At the same time you run the risk that you leave people disappointed by some aspect of what it is you were telling them.

But launch campaigns were great fun. We would all fly down to the Cape. NASA had planes at that point. I don't know if it still has planes, but NASA had its own little air force. So we would all hop in the planes out of [Washington] DC and fly down, land at Patrick [Air Force Base, Florida]. We had tents where people would come and see—press tents, so we'd give interviews, all that good stuff. Then they sat me down in the control room. I actually did have to authorize that the payload could be launched. This is after *Challenger*. So you have this huge big review that takes place just prior to flight where all the different subsystems have to say they're ready to go, and I had to say that for the payload. We had our own internal processes to make sure that was the case.

Then you go to the launch control room. They actually gave me a button. But it wasn't attached to anything when I looked under the table. But we got to listen to all the traffic on the launch and the countdown and all that good stuff. So it was a very enjoyable experience. Of course we were seeing all this huge backlog go through the system and start to do the science.

We'd then of course jump in the plane and go to usually JSC—or [NASA] Marshall [Space Flight Center, Huntsville, Alabama]. Because the payloads had to be deployed by the Shuttle. Again I had to be the one who authorized the release. I'm not sure what I would have done if we couldn't release it. Really it was never designed to bring them back, so therefore that

would have been kind of ugly. Most of the time that was a really smooth process. It gets up, the astronauts take it out on the arm, and push it away.

The Gamma Ray Observatory was the only one with an issue. The antenna stuck, and we actually had the astronauts suiting up to go out and push the antenna into position, when it said, "Oh, if you're that serious about it, the antenna will go out on its own." So it went. That was the only one that had any kind of adventure with it. The rest of them were just good releases. People did really good jobs for us. The relations between the Shuttle and the astronauts and the science program was always excellent, because they got into what they were launching. Charlie [Charles F.] Bolden [Jr.] launched the Hubble for me. There was a really good relationship between the astronauts and the science program, because they were launching our payloads, and they were interested in what we were doing. It was all a good show.

WRIGHT: At your level, did you visit the manufacturer sites as well?

FISK: I did for my payloads of course. There were a number of visits. It always intrigued me. Typically a science mission has 400 or 500 people working on it. Whenever I visited the factory there were only three guys standing around the payload working on it. I kept saying where are the rest of these guys. Of course there is all that infrastructure, design teams and things. There are only so many people that actually touch something and build something.

But we wandered around and talked to lots of folks. Of course part of the job was the flight reviews. We would conduct the flight readiness reviews. There were monthly reviews of all major programs at NASA Headquarters. There was a final major flight readiness review where we said we were ready to go.

This was again post *Challenger*, and so one of the *Challenger* issues was nobody said this isn't ready to go, it shouldn't be launched. So we went to great lengths to make sure that there was nobody in the system that knew something that would keep us from flying. So the typical flight readiness review had 500 people in it. I would stand up at the end of it, and I would say, "Is there anybody in this room that knows something that would keep us from launching this thing? If you don't want to say it publicly, here's my phone number." This was pre email days. "Here's the way you get in touch with us. But I don't want to discover after the fact that somebody knew something that we should have known when we made this launch decision."

We would go through that drill. To some extent the Shuttle was doing the same thing. We just made sure we were following the same procedures, that there's not some technician who now remembers that he did something wrong down at the bottom of the system that is afraid for whatever reason to disclose it. Nobody ever said anything, and I'm sure I did that also on Hubble, and I wish—if somebody had known that mirror was bad that they had stood up and said that. But they didn't.

WRIGHT: Before you left you worked with a third Administrator, and that was Dan Goldin. Share with us what it was like when his administration started and how NASA administration changed after he got there.

FISK: Dan is a very complicated person, as I'm sure your various history interviews have probably disclosed. First of all, he was my contractor on AXAF. He worked for TRW. TRW was responsible for building AXAF, and he was the man in charge.

So he and I had a fair number of interactions. Nothing unusual, but the same level of interactions that you would have expected for somebody who was responsible for your $1 billion program. I thought he was wonderful. I thought he was the most responsive contractor that I had.

When he showed up at Headquarters I was a reasonably happy person, because I thought this is a competent guy. Dan has two sides to his personality. For people he works for, like eventually Vice President [Albert A.] Gore, they think he's wonderful, because he answers all their desires and is very helpful.

He is impossible to work for by anybody who is reasonable. I've worked for lots of people in my life. He's the least sane, all sorts of signs of being a manic-depressive, very insecure, violates almost every management law and rule that I've ever learned in my life for effective leadership. So people don't want to work for him.

Enormous damage was done to NASA during his time as Administrator, which was long, it was like nine years. I think the most damage that was done was the talent drain that took place under his administration. Some of it would have occurred naturally, just retirement ages, getting old and stuff. But a lot of it was just good people saying I'm not going to work for this idiot. I think if my numbers are correct when he took over there were like 75 Senior Executive Service at NASA Headquarters, and within three or four years only about five of them were left. The rest had gone somewhere else, retired, got kicked out, whatever.

Enormous experience and capability disappeared from the agency at that point. If you look at NASA Headquarters today, there are good people there. There are dedicated people. But the bench strength, the uniform quality that I enjoyed as Associate Administrator and I'm sure

other Associate Administrators enjoyed within their organizations no longer exists. I attribute that to Dan.

He also had these management philosophies that there shouldn't be much Headquarters staff. When I left as Associate Administrator I had 250 civil servants and 250 support service contractors running the program. Dan took that down to a tiny fraction of that. It has grown back. But sitting here today—and I know these numbers. They have 140 civil servants and no support service contractors, and the program is the same size, and probably increased complexity.

So I don't think Headquarters can do its job at the moment in many ways. So much of that is again this legacy of driving people out of the organization. In my personal case, he and I were destined not to get along. His insecurities could not deal with the fact that I'd been there five years by that point, I had a very strong political base across Washington, that was a threat to him. So he and I were not going to get along.

Then there was Dan [James Danforth] Quayle's Space Council, which I had fought with for many years on various issues like Earth science—they didn't like a lot of the things that I was doing in certain areas, and so I have every reason to think that when Dan was hired by the Space Council to replace Truly, one of his instructions was to get rid of me. So it went downhill pretty quick when he came. I think he came in—I want to say April, May, June of '92, something like that. Truly was relieved of his duties in probably about February. Then of course they had a terrible time finding anybody. Here you are, the last year of an administration, and no certainty that President Bush is going to continue—and in fact he didn't, [President William J.] Clinton won—and no sane person would take the job under those circumstances, because the minute you take the job, if you don't continue into the next administration—and you have every reason to

think you won't, because that's the tradition—you suddenly have all these postemployment restrictions on you for having been the NASA Administrator. So you can't go back to what you were doing, and you may give up your livelihood for what could have been a six-month stint as the NASA Administrator.

So I believe again these numbers are accurate, Dan was the sixth choice. Because a lot of good people turned it down. But he took it, and came in and started his we're going to change everything because everything you guys have done is wrong and bad and all that other good stuff. We went through a very stormy time.

In I think about October of that year—may have been prior to the election—Dan reorganized. I was hard to get rid of. I was too well connected and powerful with congressional support and so on. So he did what you always do in Washington. You reorganize. So I was quote promoted end quote into the Chief Scientist position with no portfolio. The Office of Space Science and Applications was split into three parts. You had astronomy and the traditional space science, and you had Earth science separate, and you had the microgravity and life science split off.

We used codes at that point in NASA. I think they do that less today. But there was Code S, which was space science, and there was Code Y, which was Earth science, and Code U was microgravity and life science. Wes [Wesley T.] Huntress was made the head of space science and Shelby [G.] Tilford head of Earth science and I've forgotten who became the Code U guy. So it took three people to replace me if you like. I remember asking Shelby once why he chose Code Y as his code name for Earth science. He said, "It's because I can't figure out why we're doing this."

Obviously I didn't like that situation. I thought Dan would leave, he wouldn't survive the election, and that therefore I could somehow get my empire back. So I did two things. One, I did my best to make sure he wasn't going to get the job—and he found my footsteps, which only helped our relationship as you might imagine—and I started looking for other work, because I'm not foolish enough to think that necessarily the outcome was going to be either reversible or predictable or whatever.

I was interviewing and talking to the University of Colorado about a faculty position, and then Michigan discovered that I was movable, and they came recruiting, and they made a nice offer, and that's why I live here.

Dan of course ingratiated himself to the Clinton administration. He promised them that he could get the Russians involved in the Space Station, and that would be good for foreign policy. I think also the Space Station was pretty screwed up at that point still, and wasn't going very far. I think the Clinton administration made a simple decision. If he succeeds at saving this thing, we'll take credit for it, and if he fails at doing this we can say well he was just a holdover from the Bush administration. So he got to stay. He got to stay on the 16th of March. Some days are embedded in your memories. The reason that that was significant is that's when I got the offer from the University of Michigan. So I could take it more cheerfully than my staff.

One of the things that I seriously regret is that I couldn't protect the people who worked for me. I had what in my judgment was the best staff that NASA has ever had in second in commands. Deputies and Assistant Associate Administrators and so on. They were literally abused after I left.

[Alphonso V.] Diaz, who became [NASA] Goddard [Spaceflight Center] Director and eventually Associate Administrator, was a really great deputy for me. Al managed to make his

peace with Dan. So he survived. Katy [Kathryn S.] Schmoll, who was my comptroller, was parked on the eighth floor of NASA and said we're not even going to give you a computer, just sit there. She went off, and eventually she landed on her feet. Took her a while. Became the comptroller of the EPA [Environmental Protection Agency], the whole EPA as opposed to just NASA science, and then is now the vice president for finance at the University Corporation for Atmospheric Research out in Colorado. So she landed on her feet. Joe [Joseph K.] Alexander managed to find some place to go.

But one of the difficulties was Dan's Carthage-like approach—space science was a problem for Dan. In Dan's reasoning the stones are going to be scattered to the four winds, any vestige of what we had built would be taken apart. I just was not in a position to protect people. I was on my way out, and that's what I had to do.

I was amazed Dan lasted as long as he did at NASA Headquarters. There was such dissatisfaction in the agency for him as a person and his leadership styles, but somehow the Clinton administration kept him on, were satisfied I guess in some sense. Dan I think kept his job in large part by saying I'll do it for less. One of the big tragedies that exists in NASA today is how the budget fared in the Clinton administration, which had no deficits, instead surpluses. Nondefense discretionary spending went up at a fairly good clip in the Clinton administration, and NASA was held flat. If the agency had simply kept up with what other agencies were doing in terms of percentage growth of funding, if NASA had kept up with the same percentage funding growth that other agencies in the government had in the Clinton administration, we wouldn't be having the discussions we're having today. NASA would have a $23 billion, $25 billion budget. We would be able to do the things that we want to do and think the nation needs to be doing.

It mainly is a result of Dan's having said in all the years of the Clinton administration in effect keep me in this position and I won't ask for any money. The result is an agency that has been grossly underfunded ever since.

WRIGHT: The programs that you put in place, the strategies that you had worked on, how were those impacted after you left?

FISK: Well, some of the things continued, because Wes was able to keep things going pretty much. The Earth science one was the big casualty. Shelby didn't last long either. Basically he couldn't work for Dan and Dan didn't like what we had done on Mission to Planet Earth because he came through Space Council and they didn't like what we had done.

But basically in the mid '90s someplace, Ghassem [R.] Asrar is the Associate Administrator for Earth Science. The whole concept of Earth Observing System was long term observations of the Earth, 15, 20 years of observations. Because changes in the Earth are subtle. You're really trying to understand how the processes work. You're not going to see it from day to day. That's weather. You're trying to figure out the climate variations in this, and it takes long term observations to do that. So there were three sets of platforms built into the Earth Observing System. The first three were put up—they're called Aqua and Terra and Aura I think at the moment. We didn't call them that. Then they were to be replaced by equivalent systems to ensure continuity of observations for a long period of time.

NASA said we're not in the monitoring business. Even though that's what's required to do the science. Along comes the NPOESS [National Polar-orbiting Operational Environmental Satellite System] program. This is one of Al Gore's constructs; we don't need all these different

observing systems. The military has its weather system, NOAA [National Oceanic and Atmospheric Administration] has its weather satellites, and NASA has its climate monitoring systems. Let's just all put them together into one big system called NPOESS. So NASA basically trades off its continuation of the Earth Observing System to NOAA, and they lost money on it too. I don't know that they lost everything. They didn't lose maybe as much as they would have had to have spent. But nonetheless it all goes over to NOAA.

Well, NPOESS, if you follow that story at all, is considered to be the biggest debacle in the history of any satellite program that the world has ever had. It didn't work to put all these different requirements together. NASA had a very minor role in it. NOAA and DoD were doing this together. The DoD really had no interest in NASA's climate monitoring stuff. They were interested in weather for military operations. If you were putting together a checklist of how to do things the wrong way, they hit every one of the items. From management, how it was managed, how the resources were allocated, how the requirements were set and so forth.

So the program grew in budget by like a factor of four. It was eventually Nunn-McCurdy'd, which is that federal law on the DoD side that says if your budget grows by too much you have to rethink the whole program, it has to be restructured [Nunn-McCurdy Provision].

The restructuring by the military threw all the climate monitoring observations off. So at the moment the continuation of the Earth Observing System is really not there. NASA has a new rebirth in Earth science. The new [President Barack] Obama administration is putting in money. But it is so far below what we thought was necessary for the world to have for a climate monitoring system on which you could base policy decisions. It's something, but it isn't what is required. It dates back to this confluence of events in the mid '90s where NASA got out of the

business and NPOESS didn't work like it was supposed to and has been descoped out of existence basically.

There is a final chapter in NPOESS—because even having thrown off the climate monitoring instruments, they couldn't build the NPOESS that was supposed to be built. I believe this is correct. The Air Force and NOAA parted company. There are two big platforms. It's called AM and PM. They're Sun-sync, one is a morning orbit and one is an afternoon orbit. But I've forgotten which way this goes, but the military got one and NOAA got the other, and then NOAA came to NASA and said please help us build this thing. So NASA is now back in the business of doing this thing, but it still doesn't have on it the instruments that are necessary for the continuation of EOS, which is how it started.

WRIGHT: When you left the administration post in '93, you left that role with NASA, but during the years to follow you were still involved in of course the science community that impacted some of the work that was being done. Can you share with us some of the committees that you were working on? The advisory boards?

FISK: Yes. There were a couple things. One is I had a decision to make when I left NASA, which is did I want to continue in administrative positions, did I want to go do some senior administration position someplace doing something. I made a decision that I was going to return to my research career. Part of that was I was just burned out. I'd just gone through a year of hell trying to save what I could and get out.

But part of it was just I'd always wanted to retire as a professor because no one can tell when you actually stop as a professor. So you just keep going as long as you want. But it

certainly was a risk on my part when I did that, because I always joke, I was exactly 50 years old when I left NASA Headquarters. So I'm leaving a job that I liked—at least for the first five years—and I'm taking a risk that I can start my brain again to do research. Because it's so different to do research versus administration at that level. It wasn't at all certain—very few people do that. Usually when you get into administration that's a one-way trip, you don't go back and become a working scientist again. So it was a big risk.

I used to joke that if I was going to have my midlife crisis it was going to be right then and there. I'm 50 years old and not sure what I'm doing in the world. But it had a happy ending. It took me two years to get back in stride as a theoretical astrophysicist, which is what I am. Since I've been in Michigan—I think I counted it up—I've written more than 100 papers. Many of them first author. So my little brain got back in stride and did the science.

I had friends who helped fund my activities here. I have a very good longstanding colleague at the University of Maryland [College Park] at the time, George [M.] Gloeckler, and he and I had been proposing together even before I went to NASA. George essentially underwrote the activities here till I could get on my feet again and start winning things in the competitive process.

So all that went quite well. I was not basically allowed into NASA Headquarters all the years that Dan was there. There were bizarre meetings where I would go. Someone would have me serve on some committee, very minor committees. I'd walk down the halls of NASA Headquarters, and my friends would say it's really good to see you, Len. They'd be looking to the right and looking to the left, afraid to be talking to me. They'd say we have to talk sometime. They'd run off. It was bizarre. Because Goldin was vindictive, there's no other way to say it.

So I was persona non grata in any advisory structure in NASA. Until the year he left, which I think is 2002, something like that.

Within a year of that I was the chairman of the Space Studies Board of the National Academy. I used to joke that I'd been rehabilitated, there wasn't going to be resistance from the Administrator for playing the advisory role that I can do. So my real advisory role starts back in 2003 as the chairman of the Space Studies Board for five years. And on the NASA Advisory Council. Because the chairman of the Space Studies Board sits on the NASA Advisory Council. But none of that could have taken place so long as Goldin was in office.

If you like funny stories to add to your notes, I will tell you a funny Dan Goldin story. Some idiot here at the University of Michigan invited him to be the commencement speaker in the college of engineering. Now I had nothing to do with the invitation obviously. But there were legendary stories about Dan going to universities and not being treated as he thought he deserved to be treated and those universities losing their money from NASA. It was very easy to slight him. Things that normal people would not consider to be slights at all he considered to be slights. Columbia [University, New York, New York] had a very bad experience with a Dan visit.

So I know this, and I said to them, "You guys are nuts. You're going to have to go out of your way to treat him in a way you have never treated another commencement speaker before." So I end up advising the University of Michigan on the care and feeding of Dan Goldin. He comes here, and he gives the speech, and he goes away extremely happy because they treated him so well.

Of course the university then turns around and says, "I don't know what you're talking about, he was the nicest person we've ever had." I thought Michigan dodged a bullet of first

order. That was about the only time we even ran into each other again. But the word was clearly out in Headquarters that I was not to play. So from my point of view I just developed my research career and my science and there's a nice little empire here of people doing research. We hired new faculty. We're a nice successful group.

I started my own company. I have a company on the other side of town called Michigan Aerospace. So there are all these activities that I was doing on the working level, but there was no senior advice. That situation changes in 2003 when I get to be the Space Studies Board chair, and the access is back again, and I can exert whatever influence I can on the crazy world we live in now.

WRIGHT: Share with us about those boards. Even your experiences being an Associate Administrator, how those boards impacted the decisions or some of the policies that were made. Then of course when you were back in the circle again after 2003 and how you were able to influence.

FISK: Well, the most important boards are the National Academies boards. The National Research Council [NRC]. There's a board called the Space Studies Board. It was formed in 1958. It actually predates NASA. It is the nation's number one advisory board for space science. All of space in fact. There's a sister board—or brother board depending on how you do that—called the Aeronautics and Space Engineering Board which deals with everything else in NASA besides the science.

They issue reports. For many years if your science mission was not endorsed by the board, then it was never going to happen. It's that kind of influence. The main product of the

board is what's called the decadal study. It started with the astronomers, and now it's used by all the other communities as well. Basically it's a decade long plan of what that science discipline should do which is a community consensus. It's a huge effort involving hundreds of scientists to write each one of these decadals.

It's not just NASA that listens. Congress listens. Congress will not deal with a NASA program in science that does not have the backing of the Space Studies Board or these decadal studies. In fact in the authorization bill just going through one of the houses there's actually language in it that says NASA should endeavor to follow the recommendations of the decadal surveys.

So that committee is very influential. For most of NASA's history it dealt mainly with strategy. NASA had a wonderful internal advisory structure of its own which dealt with the implementation and the tactics. So there was a very clear demarcation between what the board was doing, which was long term strategy, and what the NASA internal advisory committees were doing, which were to manage the program.

In fact we used to joke that there was a career path in NASA. A young scientist starts on what's called the MOWG, a Management Operations Working Group. It's an unofficial committee, but it advises at the branch level within NASA Headquarters. Then there was an advisory committee which included the chairs of all the MOWGs which advised the division director. Then there was a committee that advised the Associate Administrator which had the chairs of all the divisions, in addition to other people, on it. Then there's the NASA Advisory Council, where the chairs of the Associate Administrators' advisory committees, all Associate Administrators if they have such committees, serve. So there was this tremendous opportunity for flow of information through these advisory committees.

It was one of the best well oiled systems in the government because not only was there a flow of information with the advisory committees, but it was possible for the lower levels to make sure that what they wanted was going to be heard by the next level up of management, because basically they would be dealing with their advisory committee, their advisory committee plugs into the next level above it. So there was a real opportunity for flow of information laterally, vertically, whatever.

This system existed up until Mike [Michael D.] Griffin. Mike Griffin becomes the Administrator and he unplugs the entire NASA internal advisory structure. He leaves basically only the NASA Advisory Council and some subcommittees which sort of are supposed to help, but they're unplugged. That whole process of the flow of information Mike makes go away.

It's a tremendous loss. One of the things that the Space Studies Board had to do when I was chair was to try and compensate for that. So we got ourselves more into tactical issues than historically had been the case because of the vacuum on the NASA side of the advisory structure. So we had a very busy five years because it was not just a matter of doing our usual strategy sessions. It was actually trying to influence how the program was being run almost at a day-to-day level.

There's some restoration going on under Bolden, but it's going to be really hard to reproduce that. It's again a loss, because it worked for 40 years very effectively. The Space Studies Board starts in 1958 and NASA has got advisory structures on its own side and if you read the interesting history of the Space Studies Board, at their first meeting they decided that they the Space Studies Board would choose the payloads for the first NASA science mission. So they send out an RFP [request for proposal] and people propose. NASA says excuse me. You're advisory. We're the government. If government money is going to be spent we are going to

decide—so there's this waltzing around that takes place in the beginning. But within a few years it settles down to this well oiled system of internal advisory committees and external advisory committees, which are independent. The Space Studies Board and academy is completely independent of NASA. NASA funds it but they're not allowed to choose the members. They're not allowed to see the reports until they're out. That independence makes it possible for Congress to look at that as really valuable advice. Then NASA had its own advisory structure. Everybody knew what they were doing until Mike comes along and pulls the plug.

I think again this is damage that has been done now. You ask why does NASA not work as well as it should work, well, you got a Headquarters staff which is too small, you had a big talent drain in the '90s and so forth, people that really would have been very helpful to have around, or at least to have a smooth transition to new people. You have no internal advisory structures, or at least a limited one. It's better than it was when Mike left, but still it hasn't been really restructured in any way. You say gee, now you know why it doesn't work.

WRIGHT: You've been in the position numerous times; I think we roughly counted about 30 plus times that you've been in front of Congress providing testimony. Share those experiences and what were some of the points that you tried to make. Are there points that you've tried to make throughout the years that tend to be continual?

FISK: I think there's so many variations on that. Testimony is always in some ways the current event at the time. Obviously when I was in NASA I was selling my program. Showing what we wanted to do. Afterwards when I was on the Space Studies Board we were often invited in to comment on the President's budget or issues like that. Especially if it was appropriations. We're

talking about the money and making recommendations. Of course some of those were also the Hubble hearings when I was being beaten up.

Again if you like amusing stories, one of my favorite Hubble hearings was with Al Gore. My staff used to claim that I—or I used to claim I had a strain at the back of my throat that kept bad comments from bubbling up. One day it slipped. Because we were having this dialogue. How much did Hubble cost. I think I told them it was $1.4 billion or whatever the number was. He said, "No, it's $1.5 billion." So we went around about that for a while.

I said, "Well, what's $100 million among friends?" It ended up on CBS News that night as the NASA Administrator that doesn't even think $100 million is a significant number. So you get those kinds of events.

There were also a lot of private hearings that you don't see. Alan [B.] Mollohan, who was the chairman of the Appropriations Committee—he lost his primary I see recently—from West Virginia. He and I knew each other for a long time. So when I became chair of the Space Studies Board we would have a couple-hour just private one-on-one meetings discussing what the board thought were the important issues that NASA should be dealing with in the budget. So there was a lot of opportunity to do congressional interactions.

The board is a wonderful position. You have a platform on which to stand. If I were to try to do that today—I have testified since I stepped down as being chair, because people deal with me, they know who I am and they ask for my opinion. But I don't have the same platform on which to do this.

There was a Mollohan hearing a couple years ago. I think it was when Chris [Christopher J.] Scolese was Acting Administrator before Charlie came on board. Nobody was testifying before Congress from NASA at that point. Mollohan had this hearing in which I was

there to talk about things in general. But I don't represent NASA, I didn't even represent the board at that point.

But I was the first person they had seen who had anything to do with NASA. So they started asking me questions as if I was the NASA Administrator practically. What did I think about funding for aeronautics? Something like that. I said, "I'm not here to talk about that. It's not my thing." At which point I got some lecture from a congressman about how aeronautics was underfunded.

I thought well if I'm going to get yelled at for not answering the questions, I'll just answer the questions. So we went through this hearing. I answered questions on—I called Chris afterwards and I said, "Sorry if I've done this to you. But I answered questions on what should be the overhead rates at Centers, how the public affairs should be. I just was having a merry old time answering whatever they were asking. They were happy with my answers. I thought if you guys aren't bright enough to realize that I don't represent anybody's official position I'm going to tell you what I think." I just found it just amusing to effectively play Administrator without portfolio I guess is the way to say it. I think actually Chris on that day was testifying before a House authorization committee on something really minor. I'm on the other side on the appropriations side, testifying on all the issues of importance to NASA, as if I was in charge of something.

I like congressional hearings. They're usually fun. There's nothing intimidating about them at this point. You can get into an interesting discussion with them, you don't read the statements, you summarize your statement. Then they ask questions. You try to answer the questions and in some ways that get them in a dialogue. That makes it more interesting.

The worst kind are the ones where there's a panel. You're just part of a panel. Sometimes you're embarrassed to be seen on the panel with some of the people that they put on the panel with you. The ones I much prefer is if somebody just lets me be there by myself. But that of course happens rarer and rarer these days because I don't have a platform from which to testify.

WRIGHT: You did mention that you just recently talked to Congress about the reauthorization for the funding for NASA.

FISK: I signed on to a letter that went out.

WRIGHT: Maybe that's what I'm thinking of.

FISK: That was a big debate on my part because there were parts of the letter that I was very strongly in support of and parts of the letter that I was not strongly in support of. It's always a difficulty. Somebody presents you with a letter that you didn't write yourself. There's no chance to change it, you're just being asked to sign on to it. There was more in it that I liked than I didn't like. After going a few rounds with the authors, I decided to sign on. The good news of that was they had something like seven Nobel laureates as the first signature. So no one has noticed that I've actually signed on to that letter. At least nobody that I think matters has noticed that I signed on to that. But I still do that sort of thing.

I don't like to do it that way because as I say you always end up with these letters where you're saying well I really think this is wrong, this is not right. But 75 percent of the letter I

agree with. You're not allowed to file a minority position. They're looking for signatures on these things.

WRIGHT: Can't initial it.

FISK: That's right. Can't initial these things. So I turned it down twice. There was a certain pleading. I joined the crowd. I did, but as I said, there were parts of it that I just wish I hadn't—I don't want to be necessarily associated with it. But there's more that I was happy to be associated with.

WRIGHT: You were able to spend time as an administrator. You've also spent time as a PI [principal investigator] as part of the Space Studies Board. Where do you feel that you've been able to contribute the most to the field of space science?

FISK: That's a toughie because I guess I'm blessed in some regards. I obviously can be an administrator. Aside from what Dan Goldin thought, I think I was a successful Associate Administrator and did a lot of good things for the science program. As a scientist, I'm a member of the National Academy of Sciences. I'm elected not because I had an administrative position. In fact it was interesting. I was probably eligible for membership in the academy long before I was actually elected. But when you go to NASA Headquarters as an Associate Administrator your science colleagues think your IQ drops by 20 to 30 points. You have to do a lot of proving that you are back to being a scientist again, because you get only negative credit in the National Academy for having been an administrator of any kind.

It's all based on your scientific credentials. So that's validation of the science portion of my life. I'm not in a very large field of science. So the impact that I have is I think fairly major, but it's contained. If you ask what have I contributed to space science as a whole. Well, then you have to go to the administrative positions or the advisory positions, because that affects science as a whole.

I'm satisfied with my career, as you might hear from this, just because I've been able to play on a bunch of different fronts in a way that not everybody has been able to do. A lot of people are very good administrators but their science careers are long behind them and now forgotten. So this idea of being able to play on both sides of that issue with practicing science and administrative and advisory roles has been a satisfying event for me.

WRIGHT: Describe your management style and your strategy in being able to achieve your goals when you were administrator.

FISK: I have a few simple things. One is I like to have a strategy. I like to know what we're doing, and communicate that to people.

One is I like to have visibility into what people are doing but not control it. I think my job is to make it possible for the people who work for me to do their job. I used to say that one of the requirements of being Associate Administrator is you have to be the calmest person in the room. So if there's any problems you are supposed to be the calmest person.

You insist upon hearing about problems in your organizations from the inside rather than from the outside. Never shoot the messenger. You want people to come and tell you what's going on. Problems will always happen. Technical organizations are always having problems.

You do not want to be surprised by something or to hear about it from outside the organization. I used to tell my staff the only time you'll ever see me mad is if I hear something from outside the organization that you guys knew and you didn't tell me.

Then you try and surround yourself with the best possible people. When we talk about Goldin—I mentioned he violated all those rules. He violated all those rules. Dan could not stand bad news. The worst thing that you could do to him to drive him around the bend was in a staff meeting report a problem. You'd get yelled at in a way that was unpleasant. It was very funny. First few staff meetings—the NASA Administrator has staff meetings. All the Associate Administrators, Assistant Administrators sit around, about 25 people in the room. Monday morning.

You go around the table. Within a week, all of us except one guy learned that we had no bad news. Whatever it was, we had no bad news. One poor guy ran the small business thing, every week would report something that was bad and get yelled at. We'd say you're just not very bright. The rest of us are learning this is not the what you do. But that's so wrong. Because how do you know what's going on in your organization to help your people solve problems if you don't hear about them. That's the kind of management style that drove us crazy with Dan.

I have a suspicion—although there's no way this ever would be proven—that that kind of attitude goes down through the whole organization sooner or later. It's not just the top of the organization that feels that kind of management style. Don't tell me any bad news management style. You wonder sometimes. Things like the *Columbia* accident where the management structure was once again not recognizing some technical event that somebody realized was going to be a problem with the hitting of the foam, and not being willing to deal with that bad news.

How much of that is the residual of the attitude at the top permeating down through the organization? No way to tell. But it's bad management.

I think people liked to work for me because I never yelled. I was really receptive to trying to help. If they had a problem, I want to hear about the problem, how can I help. That's an organization that runs well and is cheerful. Most of us came to work cheerful in the morning. We really were looking forward to seeing each other and working together on problems. Problems all over the place. We were under siege at times. But somehow there was an important camaraderie in the organization. I don't think people like to go to work at NASA Headquarters today. What I hear from the staff, there just isn't that same sense of cohesion and purpose and leadership. There are some good people that are trying to do good things, but so much of that has been lost by people that maybe don't know how to manage things.

WRIGHT: Back for a moment for the advisory committee that you were working on during the time that the vision for space exploration was announced. How did you feel that science was going to be handled as part of that major program that was being proposed?

FISK: Well, it's an interesting story. After the *Columbia* accident it was obvious that NASA needed a mission, especially in human spaceflight. It wasn't worth dying for to go up and down to the Space Station. I think it was the CAIB said that as well. So as the chairman of the Space Studies Board I thought well why don't we get involved in this act, why don't we find out, make recommendations on what the nation's space policy should be. So we held a workshop in November of 2003 which brought together about 50 or 70 of the nation's leading people in

space, not just space science. These were generals and industrial people and scientists and so forth. We held this workshop to write our own vision statement.

It's really interesting. The Academy moves at a glacial pace to put anything out. But we brought that document out on the morning of President Bush's speech in 2004 announcing the vision. There's a great deal of similarity. So the initial reaction was great, this is good, we like the Vision.

What we did not realize at that time in 2004, January 14th or whatever the date of the famous speech is, is how literal NASA was going to take that document. I joke that I think the Bush administration had some real religious conservatives in it. They were used to interpreting the Gospels according to rigorous literal interpretations. So NASA looked at that document and said well, the President told us to do this, that and the other thing. But in the science area there's no mention of the Earth. So Earth science is obviously not a priority. The Sun isn't there either for that matter in the document, so we're going to leave the Sun out. Most of the universe isn't in that document. There's search for earthlike planets around other stars as a priority. But the structure of the universe, which is eventually the big thing today, dark energy, dark matter, that wasn't mentioned at all.

So NASA within about two weeks after the Bush speech the 2005 budget comes out. They create this sand chart showing how the programs are supposed to be funded. They have exploration science in the chart, which is all the science which is literally mentioned in the President's speech—or in the policy itself, the NSPD [National Space Policy Directive] that came out. Down at the bottom of this chart is other science and aeronautics. It is clearly NASA's now lowest priority. So they bifurcate the science program into the haves and the have-

nots. You guys are exploration science, the President has blessed you. Mars, all that stuff. The rest of science is just to be put on a starvation diet for the rest of time.

One of the things the science program has always done in the history of the agency is to have some sort of balance among the disciplines, the idea being that every discipline should in fact be able to be funded well enough to make reasonable progress. We don't try and distinguish between astrophysics, planetary, space plasma physics, and Earth science. Earth science got an extra kick to save the Earth, but nonetheless there is this nominal balance. Balance was an unacceptable word in NASA, because the President had said do this, and he didn't say do that, and therefore no balance is possible.

So our enthusiasm for the vision went south within two weeks of its—and unnecessarily so. You could put emphasis on things that were directly in support of the vision. But to relegate half of the space science program to other science of no importance basically was just politically stupid. You could have faked us out. But to make it so clear that these things were not going to be supported was a dumb idea.

So then through the spring of that year you had the Aldridge Commission, and the Space Studies Board went to the ramparts and said this has got to change. We've got to fix this program and get balance back in, treat the science disciplines all as being important to the space program. Some of the exclusions were a really stupid decision when you think about it. If you want to do human spaceflight outside the Earth's magnetosphere, radiation is your biggest concern. Well, where does the radiation come from that you're really concerned about? The Sun. So there were science disciplines which were essential for human spaceflight in the vision but they are relegated down to the bottom of the heap there. So the [Edward C.] Aldridge [Jr.] Commission [President's Commission on Implementation of United States Space Exploration

Policy] did a better job by it, showing that there was to be balance in the program. When Griffin came in he made a point of restoring the balance. He took the money out for other things, but he did it in an—what's the term?

WRIGHT: Equitable way?

FISK: Equitable way, at least everybody suffered. But one of the downsides of the vision as it was initially constructed was eliminated. The main problem has just been there was never enough money to do the vision in the Bush administration or at any time. So Mike in particular took this engineering approach to life and said, "President told me to go to the Moon, what do I need? I need a rocket. That's my number one priority. Can't go to the Moon if we don't have a rocket. It's on the critical path. So therefore I will sacrifice the rest of the agency to build my rocket." There is a tremendous amount of damage that has occurred.

Life science and microgravity is the biggest single casualty. They ended up in the exploration division after all these various reorganizations, and then they ended up being the bank to support the rocket. So there really is today no use of the Space Station, despite the fact that we're continuing it—or no meaningful use. It's not that we don't use it. But the kinds of experiments that we envisioned way back when when the Station was being built, microgravity and life science are just not there. The racks are empty. The community was destroyed.

There was an event about I think in 2007 if I remember correctly where NASA summarily canceled all the extramural grants in microgravity and many of them in life science. They in one fell swoop laid off 500 postdocs [postdoctoral students], graduate students and undergraduates who were participating in that program. It goes back to that point I made earlier,

which is that community doesn't naturally want to work with NASA. They have to be lured out of the other things that they can do. They're not coming back. They were hurt by this. We were hurt here in Michigan. It's not my program, it's not my department, but there was a grant here, a cooperative agreement that they won with NASA, which was supposed to be to essentially engage the full medical school of the University of Michigan—which is world-famous—in helping NASA with long duration spaceflight issues. They were supposed to get 3 million bucks a year to do that. They never got more than $1 million, and the faculty did all the right things. They put the money all in the students. They didn't take any of it for themselves. NASA fired them all. Those guys are not going to play again.

That sort of shortsighted decisions about how to interact with science communities is really sad to watch, because I don't think the leadership of the agency at the time understood what they were doing. Mike Griffin, whom I've known for many years, he was an Associate Administrator when I was there, basically in his judgment scientists were just contractors, you turn them on, you turn them off. That's what you do with aerospace guys. They can go to work doing something else. Their company will bid NASA programs, and they'll come back if you need them I guess. Science doesn't work like that. Particularly in life science and microgravity.

If you're an X-ray astronomer, you don't have any choice but to play with NASA, because you can't do X-ray astronomy except from space. If you're a life scientist, you're a microgravity scientist, you have so many other opportunities in this nation to do your research. Space interests you, but not if you're going to be abused. So I think that is going to be the biggest single problem in any effective use of the Space Station or if anybody's really serious about long duration spaceflight, how it is that we're going to have the scientific knowledge to be able to do that, because we just kicked the good guys out one more time.

WRIGHT: What types of involvement do you have with the agency now?

FISK: I have an active research program. So I have my little grants, write my equations on the blackboard. Good theory by the way. I founded a group here. I'm not running it at the moment. I hired a young professor here named Thomas [H.] Zurbuchen who has been just a whiz, and he is now a full professor, and he runs the show. He's a hardware guy, and so we have hardware that we try to do with NASA.

In terms of the advisory roles, now it's pretty informal. I'm on one of these decadals. I serve on NRC committees. I was the vice chair of Les [Lester L.] Lyles's America's Future in Space committee, which I think was very important. It may have been coincidence but there's a lot of President Obama's new plans for NASA which overlap in significant ways with the advice that the academy, the NRC gave in that America's Future in Space report. There's some things in there we didn't think about too. But nonetheless there's synergism there.

I occasionally do other studies with the Academy. But a lot of it is just informal. My Rolodex is still there if I want to use it. I'm entering into a phase I think now where I'm trying to give advice if asked, not trying to steer the boat. I think that's probably better. I think that's appropriate for where I am in the world and what involvement I'm going to have going forward. I'm 67 now. Brain still works, I'm still happy doing this, but at some point—all the things that are happening in the space program now that are not happening immediately, new things that are happening, I will not personally participate in. They don't affect me in that sense. So I really think it's important that a lot of the advice on what to do comes from the people that are most likely to be affected by it, because they're charting their own future. I can give advice on what

not to do and what to do based on all my experience. But in terms of structuring a new program and going forward with things, in large measure it really should be the people that will be able to execute that, will have to execute the program.

WRIGHT: One way that you're lending your experience is that you mentioned you're teaching a class here on space policy. What are some of the lessons learned or some of the insights that you share with your students?

FISK: Oh, I tell all the war stories. It's a fascinating class actually. We have a program here called master of engineering in space systems. It's basically a terminal degree. People take this degree and then they go work in the aerospace industry. They're very popular. The students are getting good jobs, even in this economy. So the program is very successful. About seven years ago—I used to be chair here of the department. When I stepped down from chair, I was looking for things to put my talent into. We decided that one of the things that would be very useful in that program was to tell people how the space policy of the United States developed and where it is likely to go. Because they're going to have careers and they should be able to plan their careers about the way things are likely to develop.

Given the experience base that I have in Washington, I know how the government manages big flight programs and how it procures them, how RFPs are written, what are the tricks that you look for in an RFP and so on. I'm probably unique among professors in the world for being able to teach that sort of stuff to this kind of students, because otherwise they'd just go to a company, and the company would have to teach them—they'd learn by osmosis in the company. So we put this class together, which is 60 percent space policy and 40 percent management. It

started with a handful of students, and my class is now up to 60 graduate students, which is an enormous load. Fortunately this year I decided to have a grader so I don't have to do it all myself. But I really try and tell them what I think is going to happen—to some extent occasionally I think I discourage them. They have this positive image of things, which is not founded in fact. But I try and introduce reality to them. The policy part is just general fun. Tell stories—we go through the history of the space program, where it is today, where it is going.

The class always has a project, in fact two projects. It's hard. You can't give tests in this kind of class. What would you test? So there's a project. There's a policy project and a management project. The policy project this year is you imagine that you are a senior government official with influence in the current administration. You look over and you see how badly NASA did—or the administration did—rolling out the new changes in the human spaceflight at NASA. You tell them what they did wrong and what they should have done. What's the plan, what's the policy. Given where they are now with how badly this has been accepted and is going forward, what should they do? So it should be an interesting project. It gives them experience in thinking about how the government really works. Because certainly the rollout of NASA's new human spaceflight plan has been very poor. A lot of congressional backlash, a lot of changes being made to it. Some of which I suspect are not workable. So there's a great deal of uncertainty about this thing.

It was introduced in my judgment by how they did it. I think they could have done it—some grown-ups in the pile here someplace could have rolled out that plan out in such a way that people accepted it more than it got in its initial reaction and they dug a big hole which they can't seem to get out of now. Let the kids think about this and see what happens. But that's the nature of the class.

The project for management is we run a full selection. I take a DARPA [Defense Advanced Research Projects Agency] Broad Area Announcement, which requires a 15-page proposal for some technical system. They form proposing teams. They propose. Then I reconfigure them in selecting teams, and they select their fellow student proposals. It always amuses me because at the end of it there's always someone who complains well you didn't read my proposal or you didn't understand what I was talking about, and you should do something about that, because that's not fair.

I said, "That's what this exercise was about. The world is not fair out there. You're getting real life experience in how it is that you're going to be treated when you're submitting your proposals from the industrial side."

WRIGHT: That sounds a very neat challenge for them. As our time is starting to close, what do you consider to be probably the biggest challenge that you've had to encounter in your years of working in the space science field?

FISK: Oh, I suspect—in the science portion or the administrative side?

WRIGHT: Both.

FISK: Well, on the administrative side, certainly the Hubble was the one that required whatever skill I had to bail out the agency. That was the biggest management—it wasn't a management challenge, it was just a challenge. Because we were in such a deep hole. Of course it had a

happy ending, and everybody thinks Hubble is a wonderful success and America's telescope and all that stuff. Only a few people remember the beginning. So that's the ultimate success story.

On the science side, the good news is I'm a theorist that creates explanations for—what I really prefer is for new phenomena. Fortunately about every five years somebody measures something that's new and I jump in and offer an explanation, many of which seem to have been right. So that's why the science has been good. There is a challenge that all theoreticians face at this point in their life, which is when do you realize that you're not as good as you used to be, and do you retire with dignity before you embarrass yourself, and do you count on your colleagues to tell you that you're not what you used to be. It happens. Theoretical physics is not something you get to do for your whole life usually. So you have to be careful to know when to retire from the stage. Can't bring myself to do that yet, but I'm not sure I'm not skating near the edge here of when it's going to start, when it's not going to be as good as it was.

WRIGHT: Well, I guess a good thing for you is there always will be unknowns to theorize on.

FISK: Whether I guess right the next time, that's a good challenge.

WRIGHT: I was going to ask Jennifer. Did you have any questions or any thoughts for Dr. Fisk?

ROSS-NAZZAL: I have one question. But I don't know. It may be a simple question or it may be a very long answer. Were you involved at all in the decision to get rid of the Centaur for planetary missions?

FISK: No, that predated me. It of course was a major problem, because both Galileo and Ulysses were scheduled to launch on the Shuttle, with the Centaur in the Shuttle bay. But I only know the stories. The astronauts referred to it as Death Star 1 and Death Star 2 or something like that, because you have this big liquid thing in the Shuttle bay. I guess its demise was inevitable after *Challenger* which just reminded you of how dangerous the Shuttle is. But the main event was just what do we do. It had no impact on Ulysses because it was a light spacecraft.

So it was replaced by the IUS [inertial upper stage] I think, a solid rocket motor, to launch. Galileo of course was a heavy spacecraft, and it had to go to Venus twice and once around the Earth to build up speed before it went to Jupiter. Of course the problem with Galileo was the antenna didn't come out. They couldn't unfurl the antenna immediately after launch because they were going to Venus. The antenna was a mesh that was going to get too hot. So they left it furled until it was on its way to Jupiter, or I guess coming back to the Earth to be able to go on to Jupiter, and swing by, and they tried to open it up, and it didn't open up. So Galileo was communication-limited for its entire life. A lot of that was the result of all these extra maneuvers that had to take place because of the Centaur's not being there.

Every now and then you wonder about technical decisions somebody made. In the case of that antenna, the screw mechanism that opened it up only went one direction, because they assumed it was a simple open. If they had just put a reverse on it so you could have jiggled the thing, it would have not been a problem. Somebody made a decision that that wasn't going to be necessary, we're going to just open that antenna up. So that's the only real involvement I had with Centaur.

ROSS-NAZZAL: As the Shuttle program is closing down, we're actually gathering a lot of Space Shuttle history. I'm wondering what impact did Shuttle have on space science?

FISK: Oh, it's like any mixed story. Certainly the decision that the agency made early in the '80s that everything had to fly on the Shuttle, all payloads, in fact the nation's payloads, that was the decision that was really bad for space science. There were a lot of missions that were put on it that really didn't belong on Shuttle. They belonged on an expendable launch vehicle of course. Ulysses being the obvious case, that's a normal interplanetary mission. Fire the thing off the top of a rocket.

Then the delays in the development of the Shuttle in the early '80s followed by the *Challenger* accident essentially produced this huge backlog of missions that were just sitting around. I think I mentioned to you yesterday it cost $2 billion approximately for space science to have its missions sitting on the ground waiting for the Shuttle. That was my estimate at the time. We couldn't do new things because we had to babysit all these other missions on the ground.

So that's the downside of the Shuttle. The upside is Hubble Space Telescope. That would have been a national debacle never to be forgotten if there was no way to fix it. The astronauts used the Shuttle to go fix it. Of course all the microgravity and life science experiments, the Skylab experiments, that whole field was completely dependent upon their being a Shuttle-like vehicle available too.

I think personally the Shuttle is an amazing vehicle. You think about what it did, what its capabilities were. In some ways it was always a victim of the way it was sold. It was sold as it's going to be cheap, it's going to be frequent, it's going to be a shirtsleeve environment. It's going to just be this wonderful truck. In effect to launch all the payloads of the United States. That

was just a bad bad choice. Now maybe that's the only way it could ever have been developed. You make those kinds of decisions. You overpromise things. You overpromise things in the Space Station.

NASA has a history of overpromising things to get them sold and then not being able to deliver for the money involved. But if you just stand back and say wow, that was really a technological achievement, it really really is and was. If it could only have been possible to be a research vehicle that eventually evolved into something that might have been operational, that would have been a better deal, rather than saying it is going to be operational. Considering that it was always going to be dangerous, it was always going to be a labor-intensive thing to launch. It's like 5,000 people involved in every launch. What's the story? If you launched the Shuttle with an empty bay and discovered gold in space and you filled it up with gold and brought it back would you make money? I believe the answer is no. The cost of launching it is so high. But that doesn't detract in my mind from its technological achievement.

WRIGHT: Are there any other subjects or topics that you had wanted us to talk about?

FISK: Drained my tap.

WRIGHT: Thank you for giving us up your morning, and all the great information that you offered today too.

[End of interview]