

NASA HEADQUARTERS ORAL HISTORY PROJECT

EDITED ORAL HISTORY TRANSCRIPT

G. SCOTT HUBBARD
INTERVIEWED BY SANDRA JOHNSON
STANFORD, CALIFORNIA – NOVEMBER 13, 2018

JOHNSON: Today is November 13th, 2018. This interview with Scott Hubbard is being conducted for the NASA Headquarters Oral History Project. Dr. Hubbard is speaking with us today by telephone from California. The interviewer is Sandra Johnson.

I appreciate you talking to me again today and taking some time out of your busy schedule. When we talked last, we were discussing your work as the only NASA representative on the [STS-107 accident] *Columbia* Accident Investigation Board. While we were talking, you mentioned that Admiral [Harold W.] Gehman thought it would be a 30-day investigation. Of course it ended up being seven months. You described it as a “life transformative event” in the sense of being involved in it for that long period of time, but still having to be responsible for a Center and keeping that Center running. There were some major things going on at the time, including your agreement with the University of California for the University Affiliated Research Center [UARC], and I’m sure a lot of other things going on at the Center.

I wanted to talk about how you kept on top of those ongoing projects at [NASA] Ames [Research Center, Moffett Field, California] while you were spending the majority of your time and concentrating on the *Columbia* accident investigation.

HUBBARD: Yes. It was a juggling act. When I went to the first deployment—and I’ll use that term. The majority of the people on the *Columbia* Accident Investigation Board, which people

ended up calling the CAIB by its acronym, were military. We ended up with a lot of military terms.

When we first convened and we had not settled into the building near JSC that was our home for five of the seven months, we thought that it would be a 30-day investigation. It became clear very quickly that it was going to take much longer than that. Admiral Gehman, Hal, started preparing NASA for this longer effort. That became clear I think within the first month or so, perhaps even after the first few weeks.

I had to make a personal choice about how I was going to participate and how I was going to announce any findings or observations, because I was the only NASA person on this Board that otherwise was composed of all external people. We started off with eight. Early on we recognized collectively and under Hal Gehman's leadership that we needed to add more people. We ended up with 13, which was the same number as the Rogers Commission [Presidential Commission on the Space Shuttle *Challenger* Accident] that investigated the *Challenger* accident [STS-51L].

I started off as if it was going to a conference, going to a meeting, a NASA person on temporary duty or whatever analogy you want to draw, and realized that we could as a Board very well come across things that were critical, maybe even highly critical, of how NASA did business in the Shuttle Program. As the only NASA person on the Board, that put a special spotlight on me.

At one of the very first press conferences—this was to introduce the original Board to the world—I made the statement that even though I was employed by NASA as the Center Director of Ames, for the duration of this investigation, I was going to serve as honestly and faithfully as I could as a member of that investigation board. I was—I think I used these words—going to call

them as I saw them. In other words, I was making the point that if something came out in which there was a consensus that was critical of the way NASA operated the Shuttle Program, and I concurred in that finding, I was going to have to state that that was the honest factual outcome of our work. I wanted to make a special point publicly of saying that I was not there representing NASA, I was there representing the *Columbia* Accident Investigation Board.

Having said all that, as you just pointed out, there were a bunch of very serious and long term issues percolating at NASA Ames. The selection and negotiation of the agreement with the University of California for development of the Research Park and the UARC, the fate of the SOFIA [Stratospheric Observatory for Infrared Astronomy] mission, and lots of other things.

The way in which I worked—I believe more or less successfully—this quandary was all day every day, initially seven days a week, I was a member of the Board and doing the work of the Board. Then occasionally I would have a telecon with my two chief deputies, Steve [Steven F.] Zornetzer or Estelle Condon about the day-to-day administration of the Center, how things were going, progress on these various projects and programs.

I also evaluated my legal status with an attorney. The CAIB had a lawyer. Originally it was a NASA attorney but they felt that was too conflicted, so they had an attorney from the FAA [Federal Aviation Administration] come over and be our counselor for issues of intergovernmental relations and ethics. I discussed with him the various topics I was still following back at the Center.

He felt that these were sufficiently arm's-length and separated from the Shuttle Program and human spaceflight that my service on the CAIB was not in conflict. But I did take special pains to do that as a completely separate activity. It meant sometimes extremely long days, but that's how I kept it separate.

JOHNSON: Do you want to talk about the University Affiliated Research Center, the UARC, and how that came about? You mentioned it a couple times in that interview, but we didn't really talk about it in general.

HUBBARD: Yes. It was a way of fulfilling a long term strategic vision for the Center that grew out of the threat to close the Center, or at least convert it to a very tiny aeronautics-only Center, around 1995, and the reemergence after a combination of scientific, technical, and political actions of the Center as the home for astrobiology and for advanced computing, intelligent systems.

The way in which we felt—and I was part of this discussion for years, well before I was Center Director and then trying to implement it as Center Director—the way that one of the smaller centers in the Agency could have an impact beyond its physical size or budget would be through partnerships. They're called sometimes public-private partnerships. This would be a government-academic partnership. Creating this University Affiliated Research Center focused initially on high-performance computing, intelligent systems between NASA Ames and the University of California system. The front door for this was designated by the UC Office of the President to be University of California, Santa Cruz [UCSC], as being the one that was closest to us. With all of their work in astronomy, and also some very innovative supercomputing by a guy named David Haussler, they felt UCSC to be the one Campus that would be most aligned with us.

Santa Cruz also had a long term interest, since they were landlocked but wanted to grow, in establishing a Silicon Valley campus. They taught some extension courses in the Valley but

they wanted to have a much greater presence. The property that was assigned to Ames out of the closure of Moffett Naval Air Station, that 1,500 acres, was an area that UC thought they might be able long term to develop into a campus, an extra part of Santa Cruz.

This collaboration—which was at its fundamental basis research and research government academic, but applied to NASA problems—was, we thought, a way in which a Center with 2,600 people and a \$700 million budget, much smaller than JPL [Jet Propulsion Laboratory, Pasadena, California] or Goddard [Research Center, Greenbelt, Maryland] or Johnson Space Center [Houston, Texas], could through this partnership have an impact on both NASA and the nation's space research program that would give us a lot of visibility, effectiveness, accomplishment, and frankly staying power.

The waves of realignment, center closure, etc., roll through town regularly, roll through Washington regularly, on four-to-eight-year centers, not so amazingly correlated with the presidential cycle. We wanted to be the best in class at what we did. Ames is a research center. It's right there in the title. We weren't about to get into competition with JPL or Goddard for mega space missions like Hubble [Space Telescope] or James Webb [Space Telescope] or Mars landers, although I've been part of that at [NASA] Headquarters [Washington, DC] as the Mars Czar. But we did want to be first in class in research. With the limits on hiring of civil servants, with limits on the civil servant-contractor ratios, but nevertheless an ever expanding list of responsibilities, we approached this UARC—which at the time was the only NASA version, in fact it's one of the few around. It's distinguished from what's called an FFRDC, a Federally Funded Research and Development Center, by virtue of the legal relationship. It looks more like a cooperative agreement than anything else if you're familiar with that terminology.

JOHNSON: Yes.

HUBBARD: That's the long answer why we did it. It was done very intentionally, very strategically. When the *Columbia* tragedy happened we were in the final stages of refining and coming to the signatures on the document between UC, Santa Cruz and NASA Ames on this long term arrangement. That was one of the critical things that I had to discuss with Steve Zornetzer and company.

JOHNSON: Also in 2003 Ames was selected by Headquarters as a demonstration center to use the new Enhanced Use Leasing authority, the EUL, and what came out of that is the NASA Research Park. You mentioned a little bit about in 2005 reaching that MOU [Memorandum of Understanding] agreement between NASA and Google. At the time you said people's reaction was, "You're working with who?", and it was a different thing. But because of that and what happened even after you left, it became something that has been repeated at other Centers now. If you want to talk about that agreement and maybe more about partnering with Google in the Research Park.

HUBBARD: Right. This was another element of what we were trying to do as a Center. I called it lowering the drawbridge and embracing Silicon Valley and making that part of the Center's strategic vision.

The Center was born in 1939, December of '39. Back then it was in the middle of an agricultural area. Over time of course, by 2005, it was Silicon Valley, which then and today is considered maybe the premier technology area in the whole world.

I felt, others felt, and as you point out, after me it kept rolling, that the way to leverage this was to have agreements with the big important companies in the area. Now in 2005 you still have the legacy companies. Lockheed [Martin] had been there since I think the 1950s. Space Systems/Loral under various names had been there a long time.

The tech sector was moving from building hardware. The chip factories and places like Fairchild [Semiconductor] and Hewlett-Packard were moving a lot of that to other countries where it was now routine production, it was no longer research. The Internet was really taking off, and software development was becoming the thing. There was this upstart company named Google based on their search capability that was really taking off, and Google was expanding.

By virtue of Ames pushing the idea of public-private partnerships, the academic partnership with the University of California, but also leveraging our 1,500 acres that used to be Moffett Naval Air Station and looking to the private sector agreements, this Enhanced Use Leasing authority was granted. Getting that through the system with the folks in Washington was no mean feat, because with the exception of one or two very forward-looking people, they really didn't understand what this was all about. Ames has often been both praised and criticized for being on the left coast and having wild and wacky ideas. But many of them grew out of just where we were. Ames was in Silicon Valley, and that's high tech, and that's entrepreneurship. That means taking chances and trying new things to what the rest of the Agency maybe seemed a little far afield but made sense to us.

We got the EUL authority put on the books, and then in 2005 we had a major ceremony. Still got the picture somewhere, I think it's in my Stanford office. Anna [G.] Eshoo, our congressional representative, was off voting, so she taped a message for us and issued a press release. But Eric [E.] Schmidt, who was then the CEO [Chief Executive Officer] of Google, and

I were there. We had a signing ceremony that was the very first utilization of this authority. The intention was for Google to build up to 1 million square feet of research and development on the federal property that Ames had acquired during the base closure of Moffett Naval Air Station.

Oh, by the way, I had a little initially off-the-record discussion with Eric Schmidt as we were walking between events that it'd be really great if there was some way to have collaborative R&D [Research and Development] going on. Wall Street was already looking at Google as just an incredible growth opportunity. The net result of that was a flow of \$2 million to \$3 million a year in the other direction. In other words that Google would be sending that money to Ames for a joint research collaboration in nanotechnology and intelligent systems, a whole bunch of things that we had a mutual interest in and where there could be the use of external funds, which is not unheard-of. The wind tunnels were always paid for; if they were for Boeing purposes for example, Boeing would pay the cost of operating them. This was a research collaboration, only with Google rather than with Lockheed or Boeing.

That I believe continued for some time with my successors. Very pleased about how what was originally an experiment in public-private partnerships has turned out.

JOHNSON: Yes, it's been very successful. Other Centers are definitely utilizing it now. You stayed with Ames as the Center Director until 2006. Were there other things going on during that time that you want to talk about, or any other accomplishments during that time or things you wish you could have done and didn't get done?

HUBBARD: I just pulled up my CV [curriculum vitae] that is an outline jogging my memory. There are a couple of things that went on. One was, I think they called it at the time, a core

competency exercise where the Center Directors were all called in to explain what they did that was critical to the Agency. The long term work in computational fluid dynamics, thermal protection systems, the newer things in astrobiology and intelligent systems had to be all defended.

We emerged from that I think in good shape with the recognition particularly by Goddard Space Flight Center that Ames was—they I think begrudgingly admitted—better at computer science research. Whereas Goddard's real focus was, when they did a dispassionate analysis of it, on the big data analysis from all of the terabyte a day, or whatever it is that they get from the Earth Observing System. We negotiated as part of this core competency a reasonable division of duties between the forward-leaning research and the massive operations for the Earth Observing System.

Other things that I got done, one was the operations of the wind tunnel, particularly what's called the NFAC [National Full-Scale Aerodynamics Complex]. It's—depends on whether you believe the Russians or not—certainly the largest wind tunnel system that is in the U.S., 40 feet by 80 feet by 120 feet are the sections. It's used for landing, rotorcraft, all kinds of things. It's very, very expensive to keep in operating shape. Big mechanical systems. As I recall, it was \$4 million to \$8 million or something like that a year just to keep all the bearings lubricated and all the wheels turning in readiness to be used, which was primarily by the Army Rotorcraft Division.

They got a really good deal. They would come in when they needed it, pay some nominal operations fee, intergovernmental transfer, but not be on the hook for the big cost of maintaining it in readiness. This was at a time where I think Sean O'Keefe was the [NASA] Administrator, and being a budgeteer, a budget guy, he and his CFO [Chief Financial Officer]

and the other people in the operations areas, the kinds of things that Sean really understood well, the overhead of the Agency, those people were putting a real squeeze on the Centers to get the overhead rates down as low as possible.

That meant wherever you had something that you were taking the millions of dollars a year out of some account that was called some version of overhead, that needed to be reduced as much as possible. So I announced to the Army that I was going to close that wind tunnel. The next thing I knew, a four-star general was on my doorstep saying, “You’re going to do what?”

I said, “I’m going to close it. My bosses up the line are saying I’ve got to slash overhead. The alternative is to lay off a bunch of contractors or do a reduction in force for civil servants. That doesn’t make any sense. We don’t have a big rotorcraft operation any longer in our portfolio. The big operator is the Army.”

He looked me in the eye and he said, “Well, I came out here to see if you’re serious.”

I said, “I’m serious as a heart attack.”

He grumbled and grumped and griped and said, “All right, well, I guess I’ll have to do something, because this is important to us.” The four-star left and a week or so later a two-star showed up to carry on the negotiations. Long story short, we worked an agreement where the Army rotorcraft through this place in Tennessee that operates a bunch of other facilities for the DoD [Department of Defense] would take over the operations and cost, most importantly, of this for the DoD with the Army as the lead agency, and that NASA would still have rights to come in and use it. We used it very successfully to test one of the parachutes for landing the Mars rovers. That was done like a year before the mission was to launch.

That was one of those operational things. There’s no press releases. Maybe there was a press release somewhere. Arnold Engineering is the name of the entity that operates all these

DoD facilities out of Tullahoma, Tennessee. It was one of these things, though, that I had to put my attention on, because it was a directive straight from the top that had a major impact on the Center.

JOHNSON: Were there other wind tunnels that were having to be decommissioned while you were there?

HUBBARD: There was one that was decommissioned while I was there but before I was Center Director. In fact that was part of a big push. I think it was a 14-foot wind tunnel. That building in fact got demolished. But the so-called Unitary Plan Wind Tunnel was very busy, did a lot of work for NASA, government agencies, Boeing, private groups. Boeing was doing the finishing touches on its 787 [Dreamliner] at the time. People were talking about, as they always have been, Shuttle replacements and hypersonic aircraft. That one is still in business I believe. It's very productive. But there are others that were closed before. As I said, I was able to hand off the NFAC to the Army, to the DoD.

JOHNSON: I know a lot of the wind tunnels, like at Langley [Research Center, Hampton, Virginia], some of them had historic designations. Were the ones at Ames that way too?

HUBBARD: Yes. Any of the ones that had been around 50 years or something like that. Many of these had their roots far older. Ames was always in battles slash discussions with Langley and to a certain extent with Glenn, [formerly] Lewis Research Center [Cleveland, Ohio] about which

wind tunnels were really necessary. Every time one of these reviews took place, there would often be a closure, or at least a mothballing. It would go into hibernation.

Some cases, these wind tunnels were initially deliberate duplicates. Langley was founded in 1915. Ames was founded in '39. Lewis was founded in 1940, anticipating World War II. The planning was "Gee, if we're invaded by the Germans, that'll be Langley, we need something on the west coast. If we're invaded by the Japanese, we need something in the middle of the country." A lot of this planning initially was for facilities that could backstop each other and also handle the huge amount of research that was with the advent of the jet airplane and the advanced fighters, the P-51. Over time these wind tunnels evolved into specialized things. It was a little bit easier to say why this wind tunnel, which looks a lot like the other wind tunnel, is really different. Those types of things went on every few years.

Another thing I was very much involved in was the nanotechnology work. That was another very advanced technology at the time that we had to demonstrate how it would benefit space projects. But we ended up with a segment of our money going to that.

In terms of the things that I didn't like but had no choice over—I think this was during O'Keefe's leadership. My career as Center Director spanned from O'Keefe and then into [Michael D.] Griffin. After [President] George W. Bush's announcement of *The Vision for Space Exploration* in 2004, Mary [E.] Kicza, O'Keefe's Deputy in particular, and O'Keefe, and a few other people who were in the front office on the ninth floor there in Washington decided that to follow *The Vision for Space Exploration* they needed to redirect funds into two new launch vehicles, the Ares I and the Ares V, and a lunar lander and a whole bunch of other hardware.

One of the things they did to gather up that funding was to abruptly cancel the Gravitational Biology Program at Ames, which had funding at one time on the order of \$100

million a year if I remember correctly. It was the major research program, including spaceflight hardware that was called the Biological Flight Research Facility, with a centrifuge that would allow you to do one-g versus zero-g or even partial-g comparisons to see what would happen if you had organisms in long term weightlessness. The mouse model was a typical one. Mice and rats are for research purposes good analogues of human being. That would be a way of examining the effects of living on the Moon or going to Mars.

That facility was abruptly canceled. All the money—or most of it, I should say, 90 percent of it—was taken and moved over to *The Vision for Space Exploration* Ares I, Ares V, lunar lander, etc., projects. That meant that after I registered a series of objections we were told, “No, no, this is a decision that we’re going to do this. We worked it with OMB and that’s the direction.” I had to end up laying off 300 contractors, and that money went elsewhere, and that was a huge blow to the Center.

I told them at the time. I told Mary Kicza and who was O’Keefe’s Deputy?

JOHNSON: Fred [Frederick D.] Gregory.

HUBBARD: Fred Gregory, that’s right. I said, “Look, you guys, there will come another day when you’re going to have to justify the existence of the International Space Station and the \$2 billion a year you’re spending there, and I’m telling you right now the only justification for that is research for long-term stays in space. That’s not only astronauts, it’s what else happens to any living system. You’re canceling this money. The research community is going to flee and rebuilding that is going to be a very difficult thing to do because you can’t turn research on and off like you can turn engineering on and off. If a professor accepts a student to get a PhD that’s a

five-year commitment roughly, and if they think their funding is going to be up and down and in and out, they're not going to play in that game, they're going to go to NSF [National Science Foundation] or to the National Institutes of Health or something like that." That's what happened. The gravitational biology community dwindled down to almost nothing, and now over the last 10 years there have been numerous attacks on what's the Space Station good for after all and what research has it produced.

I would argue if that Biological Research Facility was there you would be answering the questions about the journey to Mars and is one-third gravity good enough. Instead people are having to guess at it. That includes one-sixth gravity on the Moon by the way. That was one of the most disappointing things that happened during my tenure.

On the other hand—I think we've talked about this—we were able to bring on the world's fastest supercomputer at the time, and Ames is still leading the world, certainly the Agency, in supercomputing. There's probably not, unless he or she has been extremely lucky, a Center Director who hasn't had some ups and downs or the rough with the smooth as they say.

JOHNSON: They all have, because you are at the mercy of funding and directive from NASA.

I know I asked you that before, but is there anything else about that time that you want to add before we go on to when you left?

HUBBARD: Let me just read through what I wrote in the CV here. There were issues. The problems in the development of the SOFIA Project.

JOHNSON: I was going to ask you about SOFIA. I'm glad you mentioned that.

HUBBARD: SOFIA, the Stratospheric Observatory for Infrared Astronomy, like many major projects, has a long history and took longer and cost more than planned to bring it to fruition. But NASA is always trying to do things it's never done before.

Now, what, 30 years ago maybe, there was an airborne infrared astronomy platform called the Kuiper Airborne Observatory, the KAO. They modified an old transport [Lockheed C-141A Starlifter] into this demonstration that you could do astronomy with a 1-meter class mirror from a modified aircraft. The Kuiper, as it was known, named after Gerard Kuiper, famous astronomer, was very productive, very successful. It had certain drawbacks in that it was a military airplane that had been modified, and to be a researcher on there with your instrument you had to actually get certified as part of the crew, which meant training for what happens if you're depressurized and all sorts of other things. But plenty of astronomers were willing to do that, and a lot of basic research, particularly about the outer planets, came from that airborne observatory.

You can say, "Well, what's the value of an airborne observatory?" You can change instruments out, unlike spacecraft. You can get above 90 percent of the atmosphere at 40,000 feet and 95 percent of the water vapor. That's the really key thing if you're doing infrared measurements, because the water vapor in the atmosphere blocks the infrared. But the Kuiper reached the end of its life.

As part of the decadal survey process pioneered by the astronomers starting in 1960, I think the 1990 decadal survey, it was either 1980 or 1990, said the next big things we need are a major space telescope and a replacement for the Kuiper Airborne Observatory. That led to

Hubble, and it led to the beginnings of the SOFIA Project. Yes, must have been the 1980 decadal survey, because some of the early studies of SOFIA were about 1984, thereabouts.

The good thing about being in one of these National Academy study decadal surveys is that Congress treats those as the Bible. They say, “You’ve spent a year and a half, canvassed hundreds if not thousands of scientists, and beat each other up and come out with a consensus, and so we know this is serious, it’s well done, it’s grounded in the best fact and planning that you can do.” If you get a project in the decadal survey, eventually it gets funded.

SOFIA got going in the mid ’80s just as conceptual studies, and it was finally funded I think about 1995. But this was right in the middle of Administrator Dan [Daniel S.] Goldin’s love affair with faster, better, cheaper. He told Ames, which was lead responsibility for SOFIA, that the government was not the solution. The government was part of the problem. We had to create a single call for proposals, write a single contract for development and operations and science instruments, and then get out of the way, and hallelujah, a miracle would occur. Of course mostly that’s not true. These are one of a kind projects that the contractors generally don’t have any better idea, and of course often worse idea, than what NASA does about what needs to be done.

The Center—this was well before my tenure as Director—was told to implement this. One contract was solicited for covering the whole thing. The selection was an academic group, University Space Research Association, USRA. The selection authority, the source evaluation board, did not select Lockheed, which might have worked better. Who knows? But USRA as an academic institution had to turn right around and have a subcontractor that knew about modifying airplanes, and they picked a group that went through a lot of name changes, down in Waco, Texas (the company was called L3 Technologies during my tenure). A Boeing 747 was

picked out of the boneyard in the desert. It was the *Clipper Lindbergh*, named for Charles Lindbergh. In that rough way it got started.

Because of this unusual experiment in contracting oversight and responsibilities, problems kept cropping up, and SOFIA had schedule problems that turned into budget problems. During my tenure there was a major review, which wasn't quite a cancellation review but might as well have been, and I put a lot of effort, as did my staff, into convincing the people in the astronomy and astrophysics group, the Science Directorate, that this would in fact be able to meet its commitments.

We also though said quietly, "This arrangement where one contractor that really is an academic institution is responsible for everything is not working." We during my tenure set the stage for eventually splitting that contract and giving the academic group responsibility for running the solicitation for the instruments and the science teams, and having a separate contract with proper oversight by aeronautical engineers for the modification of the aircraft.

Subsequent to my time I think the operations of the aircraft migrated from Ames down south to Dryden [Flight Research Center, Edwards, California], which is now Armstrong. Whether that's good or bad I don't know. I think if you separate science from the operations you end up with different goals or different incentives. But nevertheless SOFIA survived through my tenure and got a new life, and we started to repair some of the harm that had been inflicted by yet another interpretation of faster, better, cheaper.

Goldin I think if he had been Administrator during the era of the CubeSat [nanosatellites] might have been a lot happier with some of that. But I was once asked in an interview what kind of a grade I would give Goldin, and I said, "Well, for support of astrobiology and searching for life in the universe I would give him an A. On other things I would give him an incomplete."

JOHNSON: Since we're basically at the end of your tenure with NASA now, one of the questions I like to ask people, especially people that have had that experience as Center Director or worked at Headquarters, is to talk about those different personalities of Administrator that you did work for. As we know, Administrators change depending on the President we have at the time and the presidential administration. We've had engineers, we've had astronauts, we've had scientists, and we've had people that were not even involved with NASA before, as we have now.

Talk about some of the ones you worked under. I know you worked under Mr. Goldin, Sean O'Keefe, and Mr. Griffin.

HUBBARD: My first interaction with an Administrator was Admiral [Richard H.] Truly. He was in office when I came to NASA, and so I caught just the tail end of his tenure. Former astronaut, more of a flight person. I observed that he was thought of by the rank and file as somebody who would be very much engaged in human spaceflight but perhaps did not know a whole lot about the other parts of NASA. Maybe something about the aeronautics piece.

Then we went through the hiatus there between administrations and Dan Goldin was appointed in I think 1992. Is that right?

JOHNSON: Yes, April 1st, 1992, you're correct.

HUBBARD: The couple things that I remember in there. One was the famous, infamous 90-day study. I had a role in that. I believe I already told the story of where Mars Pathfinder came from. Goldin was a force of nature. All the stories, I think I've told a few. Like some of the

stories they tell about General [George S.] Patton. You didn't know when he was acting and when he was genuinely mad. To which Patton famously said, "That's fine, as long as I know the difference. Doesn't matter if they know the difference or not."

We got lots of support. Goldin initially tried to close the Center and then was faced with political reality of the [President William J. "Bill"] Clinton administration being in power and was told, "No, you're not going to do that." Then as a result of planning and work and effort that everybody put in we ended up with intelligent systems and astrobiology and the NASA Astrobiology Institute and a lot of things I was very much involved in.

It was Goldin who told me to establish the Astrobiology Institute and then he told me to come to Washington and fix the mess in the Mars program, which I think I did. That sort of individual, I call it where's the center of gravity. If you weigh or measure all the ups and downs, all the positives and negatives, he was the longest-serving Administrator. On balance I think he did good. But you'd certainly get an argument from a lot of people about whether it's 51 percent to 49 percent in that. We at Ames, by virtue of being prepared and having a way to push back on some of this, had an outcome that was positive on the research side.

Then there was the transition. I think we went then to Sean O'Keefe.

JOHNSON: Yes, there was a little one-month period with an Acting Administrator [Daniel R. Mulville], but yes, Sean O'Keefe was next.

HUBBARD: Sean was the one who appointed me as the Director of Ames on the basis of a recommendation from his Associate Administrator for Aeronautics. That was the time when each Associate Administrator had responsibility for one of several Centers. The Aeronautics

AA, Jerry [Jeremiah F.] Creedon was his name, had responsibility for Langley, Lewis, Ames, and Dryden. Sean wanted to make a change, and I was recommended. I met Sean, who was budgeteer from OMB [Office of Management and Budget], and briefly the Secretary of the Navy, and was very much interested in more the business and management aspects. I drew on my experience already with the Research Park and public-private partnerships. One of the things I said in my CV is “streamlining operations.”

What that means is that I tried, I think with some success, to have the legal team for example say, “Yes, if,” not, “No, but.” By that I mean if somebody had an innovative idea, the first response of the legal team or the procurement folks was not to be, “Well, no, you can’t do that, well, but maybe if this is modified you might be able to do that.” Rather to come in and say, “Yes, we can do this, if we resolve this conflict and take care of that thing.”

I was attempting to fix or change what the researchers would complain about continuously. I heard this as a lower level employee. I heard it when I would hold town hall meetings and meetings with division chiefs. The researchers would constantly complain that some combination of procurement personnel and legal was keeping them from doing innovative stuff that they wanted to do.

Of course you had to look at it from the perspective of making sure that the Center did not get involved in anything that was going to end up as an embarrassment in the *San Francisco Chronicle* or the *New York Times*, nobody was going to go to jail, and that the fiscal responsibility was in place. Within that what I wanted to do, and I think had some success at, was to change the relationships, the respect, and the attitudes to realize that this was a research center and that we had to produce top level research, leading-edge research products, in order to have our standing in the Agency and continue into the future. That included these government

public-private partnerships, and I needed the help of procurement personnel and legal to make that happen. I digressed a little bit, but part of my pitch about why I should be Center Director—my sense was O’Keefe had already made his decision—was that O’Keefe wanted to just hear from me personally a little bit about what I would do.

The phrase that I used with Sean was that I would move Ames ever so slightly from “University of Ames” toward “Ames, Incorporated.” What I meant by that was that I would try to keep the culture of research but be sure that we had things operating on a fiscally sound approach, and would emphasize—which we did through the UARC and the EUL and Research Park—this outreach to the rest of Silicon Valley.

[During my tenure as Center Director, there were two management/executive leadership issues that caused a great deal of discussion, concern, and effort at all of the Centers: Full Cost Accounting and the role of the Center Director.

In the end it required years to resolve the desire to migrate to "Full Cost Accounting" and for NASA to get a "clean" financial audit. That particular initiative began well before O’Keefe took office as Administrator. However, since he was a budget and finance guy, the topic took on a special focus. There were a host of technical accounting issues that needed to be resolved. For example, unlike the rest of the nation, government agencies do not depreciate purchases. That meant there were millions of dollars of old computers that went to surplus property but somehow "not accounted for" financially.

However, the most serious issue was the attempt to put NASA civil servants on the same footing as, say, a Lockheed employee. Budgets meant to pay the legally mandated civil servant salaries were redistributed to program managers who in turn were instructed to make decisions about "who to hire." This move to not only "full cost accounting," (where did the money go?)

but to full cost management, was deeply disruptive, especially to the civil servant scientists and researchers who typically were not assigned to a single particular project. The ripple effects from what some saw as a thinly disguised move to force people out or conduct a reduction in force created years of angst and consternation. My understanding is that eventually the top leadership was convinced that civil servants had, by law, to be paid. Civil servants could not be treated as at will industrial contractors.

The second topic of the role of the Center Director was closely connected, I believe, to Sean's former military appointment where there are "Base Commanders" in charge of (as they say) roads and commodes at a given base. The Wing Commanders have the mission and execute the programs of the DoD. In this analogy, O'Keefe saw Center Directors as Base Commanders and the Program Managers as the Wing Commanders. This theory of organization resulted in many a complex and contorted org chart where civil servant staff who nominally reported to the Center Director also had a dual line to a Program Manager at another Center or Headquarters. In early versions, the Center Director was effectively a bystander unaccountable for the success or failure of any project at his/her Center.

Such a separation of accountability and responsibility was not sustainable. After several years of confusion, and some dropped balls in project execution, the restoring forces of proper oversight were put back in place. Center Directors are once again responsible for the projects at their Center.

In the end, these experiments in management, as was the case with "faster, better, cheaper," seem to be put into place for ideological reasons without proper vetting or oversight. But – NASA seems to have survived anyway.

There was one other aspect of Sean's approach that caused several of the Centers some personnel challenges. O'Keefe was very influenced by his experience with the Navy and as such had a very different view of how Center leadership should operate. He was familiar with the two to three year "postings" that were part of the military culture. Every Base Commander expected to be moved regularly. Thus, at one point early in my tenure, Sean made the directive that the Center Director and Deputy Center Director could not both come from the same Center. That resulted in several moves at Ames (e.g., a Deputy being assigned from JSC) that I believe were counter-productive. While I understood O'Keefe's motives to introduce differing points of view by moving people around, the necessary expertise to understand how a research culture differs from a (e.g.,) human space flight culture was missing. At Ames there was an SESer [Senior Executive Service] who thought this policy was used to discriminate against women. She filed an EEO [Equal Employment Opportunity] complaint and I believe NASA settled out of court.]

Sean was there for what, three years?

JOHNSON: He was there from end of 2001 to the beginning of 2005.

HUBBARD: Then another change of administration, and Mike Griffin came in. Mike was well known to me. We'd first interacted back in the days of Clementine [mission] and SDI [Strategic Defense Initiative] and Star Wars. I was part of a group that looked at what kind of sensors should be on this demonstration mission that the DoD was creating called Clementine. It was going to go past the Moon. Mike was very much a technologist and very much a Washington creature. Sometimes I wondered how he got any work done when he went for I think five

different degrees, something like that. It was enormous. Either he never slept or he spent most of his time in school.

At any rate, Mike had very, very strong opinions about how things should be done. Politically I think he was a pretty conservative Republican and was a political appointee of course, but he was aware that the NASA folks were going to go about their business in a nonpartisan or bipartisan way.

Those are the ones that I've known closely.

JOHNSON: I'm sure it's interesting working with those different personalities.

HUBBARD: Yes. It's an interesting thing. If you're an SESer, you have fewer protections. That was the deal supposedly is you give up some of the General Schedule protections of the rank-and-file civil service in return for higher pay. With all of the pay compression, the difference ended up being marginal.

But the beauty, the brilliance of creating a permanent civil service that takes its marching orders not only from the political appointees that come and go, but also in the case of Ames and research long term commitments of a scientific nature—you don't explore Mars in one presidential cycle. But at the same time, in order to sell programs, you often had to talk to these political appointees about what could be done during their four years or their President's four years. It really results in a kind of often strange psychology or sociology. You're trying to be faithful to, let's say, a decadal survey, where the scientists of the world get together and say, "This is what we want to do over the next 10 years," versus a rapid changing political

environment where people come and go and are often driven not by some long term vision, but by the 24-hour news cycle or whatever's happening. It's quite a balancing act.

The closer you get to the top, the more you have to develop the skill. That's why I think a lot of people in the—let's take a GS-14 electronics engineer. Many of them are perfectly happy to not be a branch chief, not be a division chief, wanted nothing to do with going up and being responsible at a higher level. They knew if they stayed where they were they could focus on electronics design, electronics research, writing papers, going to conferences, helping train the next generation, and doing good work, and didn't have to get into this, what they regarded with some justification as bizarre, world of talking to political appointees, who were worrying about scoring points in advance of some upcoming election, versus doing the long term work that research takes.

That's just some of my philosophical musings based on 45 years' worth of living in the environment.

JOHNSON: In 2006 you made the decision to leave NASA and you went to SETI [Search for Extraterrestrial Intelligence] as the Carl Sagan Chair for the Study of Life in the Universe at the SETI Institute. Around that same time there was a lot of budget cuts coming down as far as astrobiology was concerned, which you had helped develop at NASA and set up. SETI was going to be looking for private funding after that because they were losing some of their funding from NASA.

Can you talk about that transition and why you decided to move from NASA to SETI and about that time period and the funding?

HUBBARD: I don't remember the exact timing. There was something on the order of a 50 percent cut in the overall astrobiology budget. That includes the grants program, the Institute, some other things. There was some speculation that this had to do with the religious right thinking there was something wrong with this. Other people said it was simple arithmetic, that that budget stood out, and when they were searching for other money to fund whatever was *The Vision for Space Exploration* at the moment, that was a place to go and get the funding. Whatever the source of it, it was something that hit the whole field very hard.

But to go back to the fundamental question, when Griffin came in, as I said, he was known as having very fixed opinions about the right way to do things. He went on, I would think, and I never bothered to add up the numbers, but a rather extreme purge of the Agency. He changed out I don't know how many senior level people. The senior executives can all be moved within 120 days. He changed out an enormous number of Center Directors. The stories were that the only reason he couldn't change the Director of JPL was because that's a contract between Caltech [California Institute of Technology] and NASA, it's not subject to the same civil service rules.

But I sustained in there. Mike though in his unique way kept looking for his team. He was clearly much more comfortable, even though I'd known him on and off over the years, with people from the DoD. It became clear that he wanted his own team nearly everywhere, and that included his friend Pete [S. Peter] Worden, who was just then out of a job. I don't remember the details of his transition from being a one-star general to—he was at the University of Arizona under some grant agreement. But as I said to the media at the time, it was made very clear that Mike wanted his own team, and rather than get into some kind of unseemly public fight, or the kind of fight that I saw some people do where they went to their congressmen and senators and

tried to pressure Griffin through that route, I had then a long career of accomplishment behind me and I thought that taking a period of time to focus on doing something that I really enjoyed, which was astrobiology. The people just across the road at the SETI Institute were very welcoming, and I knew a lot of people at Stanford [University] of course, and they said, “Well, you can be a visiting scholar.”

I don’t know if in your interviews people have talked about all of the rather substantial ethics issues that are involved if you’ve served at a very senior level like Center Director. But in my case the attorney wrote me a 15-page opinion of what I could and could not do, at least during the first year, the second year, and in some cases for life. You have a lifetime prohibition if you’ve been personally and substantially involved in a particular matter from ever representing that matter back to the federal government.

Most of the most restrictive things occur in the first year after you’ve left a senior position. There’s certain exceptions for qualifying institutions of higher learning or nonprofits. Both Stanford and the SETI Institute qualify for that, and so I was able to move and do things reasonably easily.

But the year at the institute where I established a whole group of astrobiologists was in part working on something I found personally very interesting, I think I said since I was around nine years old, and also served as part of what’s often known as the cooling-off period where you have to be exquisitely careful if you’ve been a senior executive, something like Center Director, been selection official for big contracts, about whom you talk to.

That was the source of my transition in that year there with the institute. Then I moved over to Stanford essentially full-time.

JOHNSON: You're continuing of course your interests that you started out early on with human and robotic solar system exploration and research into life elsewhere and how it affects the Earth and how it began on Earth.

HUBBARD: Yes. After this year of transition the people in the engineering school in what is effectively the aerospace engineering department—Stanford like MIT [Massachusetts Institute of Technology, Cambridge] has its own name. It calls it the Department of Aeronautics and Astronautics. They said, "We'd really like you to come over and help train the next generation, and oh, by the way, we need some new programs. Can you help us find some new programs?" That was a great offer. Great people. Didn't have to move. Many people that I've known that have gone all the way up through Center Director or Associate Administrator at Headquarters will go and then work for some period of time with Lockheed or Boeing or someplace like that, because that is work that they can do effectively and also help build their retirement plan. Pay in government, particularly at that level, is often a fraction of what people in industry make.

I rather enjoyed the academic environment, doing research. They made it clear that at the age I was at then, which was about 60 some odd, I would not be a candidate for a tenure-track position. They're interested in hiring people that have done a PhD plus postdoc and are in their 30s, not somebody who's 60. But that's fine. They had various names for it. The current name is adjunct professor.

But I worked with the previous chair, Brian [J.] Cantwell, who I still work with, and the current chair, and over the last 10 years have been involved in a number of very interesting things. One is I finally got the time to write a book about my restructuring of the Mars Program,

which actually did win an award. It says award-winning here, that's true. *Exploring Mars: Chronicles from a Decade of Discovery*.

When you have been in a senior leadership position, certainly involved with science and science missions, you become fodder, fresh meat, for these National Academy studies, because they want people who are knowledgeable but no longer conflicted by working for the government. So I've served on a number on a number of National Academy studies. The last decadal survey for planetary science.

The two things that I set up—actually I'll talk about three things. One was I led the charge of putting together a coalition across multiple schools in a proposal to the FAA for something called the Center of Excellence for Commercial Space Transportation. I've been interested in this ever since my time at Ames, very early days, when people were just starting to talk about personal spacecraft, and my meetings with Elon Musk in 2001. I led the successful proposal to the FAA. I was the director of the center for its first five years. Got through the transition, it was renewed for a second five. Then I stepped down and handed it off to another member of the faculty. That's allowed that group to continue working in things like space traffic management.

I also established a program working primarily with JPL on something called the Mars Ascent Vehicle. It's a key technology for the Mars Sample Return. That's a science mission. My good colleague Brian Cantwell there, a professor, member of the tenured faculty, he was the chair who originally recruited me to come over to Stanford. After all this work, the technology that Brian and a postdoc had created years ago I recognized had some potential for being used in the Mars Sample Return as the rocket that would launch from Mars and carry the samples back to a waiting orbiter.

Long story short is that is now the baseline vehicle. A company Brian is partly invested in as well as another company are the two subcontractors who are working to demonstrate that this would be successful. That brought in enough funding to the department to support, or partially support, three or four PhD students. I've been actively involved in advising those students. Research advising more than lecturing or teaching has been my primary activity there.

Along the way I was also able to establish a journal called *New Space* that is to my knowledge the only peer-reviewed journal that's devoted to the emerging entrepreneurial space industry. That's been quite an adventure to get that going, because so much of what's happening in the new space realm, whether it's SpaceX or Virgin Galactic or a host of smaller companies, there's a tendency for them to work through press releases, and not through any kind of peer-reviewed materials.

But occasionally you can convince them to write something I call a perspective. It's a little bit more than an op-ed. It's more extensive. Elon agreed that we could take a talk that he'd given at a meeting of the International Astronautical Congress and he would work with us to turn that into a perspective, which we did. That issue of the journal with his article in it has now been downloaded over 500,000 times. It's 500,000 plus and counting. It's been a successful adventure there.

Then another thing that I got involved in, I'm still working on, is working actually for SpaceX. That's the nice thing about being in academia is you can pursue numerous interests and not have them be in conflict with one another as it would have been with NASA or if I'd gone to work for a major aerospace firm. I serve as the chair of the SpaceX Commercial Crew Safety Advisory Panel. We go in a few times a year and look at what they're doing with that program, and then I write a letter. I have three former astronauts, Leroy Chiao, Ed [Edward T.] Lu, and

Mark [E.] Kelly, who's the identical twin brother to Scott [J.] Kelly, and then the former flight surgeon at Johnson Space Center is Richard [T.] Jennings, and the former launch director at Kennedy Space Center, Bob [Robert B.] Sieck, on the panel. We give advice to Elon and Gwynne Shotwell and the other people at SpaceX about what we see and what we think would make it better.

So have been doing this whole collection of things for about 10 years now. Just very recently, something that's not on here is helping the department for the first time ever establish its own undergraduate program. Stanford Aerospace Department has been graduate-only from its founding in '58 until now. Faculty is capable of chewing things over for decades without coming to a conclusion, but they finally realized that for the future of the department, they needed to create an undergraduate program. I've been helping them in particular with a space policy course that the students demanded, and really nobody on the faculty other than myself had had that kind of experience with Washington, DC, and federal funding and regulation and legislation. But the students are all very interested in it, so the department said, "Well, if there's this much interest we have to do something." One of the things that I've worked on over the last year or two has been helping them with that program.

JOHNSON: It sounds like you have a very full career in your after-NASA career.

HUBBARD: That's probably going to come to a sunset as well. I'll reach a milestone here in about a month. I'll be 70. That's probably enough – certainly working where I am busy all day every day. I'm going to step back to just doing a few things.

I'm actually at this point down to just one day a week at Stanford. I have one PhD student I'm still helping get through the system, and will not take on any new students. Just try to make a little more time in the day for doing some other things.

JOHNSON: I think you deserve it.

HUBBARD: Thank you. I think that kind of brings us up to date.

JOHNSON: One thing I like to ask people at the end of these interviews, and we've talked about some of them. If you look back over your entire NASA career—which you've had a very long NASA career—what do you consider your biggest challenge in all your various positions and jobs?

HUBBARD: With NASA the biggest challenge is not technical. There are huge technical challenges. Look at what it's taken to get the James Webb Space Telescope going. That was a case of overreach, people wanting to do so many things that had never been done before, and ended up taking a lot longer and costing a lot more than anybody expected.

But in the programs that I've been personally involved, at a high level it is the need to create when I was involved in the Mars Program what I called program system engineering. What you're dealing with is not only some deep technical issue that needs a new widget, needs a breakthrough in performance or capability, but you also have to mature that where it can be turned into part of a project. Then you've got to stitch those projects together in some kind of

architecture with a strategic vision where you've got parts of the organization spinning at much different speeds. I've alluded to this already.

You've got the budgetary part that runs a year at a time, and you're always working in three different fiscal years. There's the one that you're in, there's the one that's coming up, and there's the one you're planning in the background. You've got to work with all these personalities across fields of technology, science, legislation. I'm talking about things at a pretty high level. It's being able to keep your eye on a strategic goal while balancing all these competing interests and making something out of nothing.

I think that if I've had success in any area it has been taking an idea like the Astrobiology Institute—which was Dan Goldin waving his hands and saying, “I want an institute but I don't want to pay for it. I don't want to pay for bricks and mortar. It's got to have all these. Just go do it. Or here's a mess called the Mars program. Go fix it.” Or the journal or any of the things that I'm doing now. Creating something of value out of maybe, not nothing, but out of something that didn't really exist in that form before, and having to pull all the pieces together with all the different personalities and different incentives that people have. Getting them to cooperate and making it happen. That's a long-winded answer to your question.

JOHNSON: No, that's a good answer, and you named different things and some of those challenges that you had. But is there anything that you consider your proudest accomplishment? The thing you're most proud of?

HUBBARD: I think it would have to be the Mars Program, the staying power of that. Of course I'm proud of being given the authority, responsibility up through the years leading larger and

larger organizations with more people involved, greater level of funding and budget involved. But in terms of something that has stood the test of time and produced just really some extraordinary results, I think what I did there with the Mars Exploration Program and where it's now headed gives me a lot of satisfaction.

JOHNSON: Before we close, if you don't mind, I want to go back to something you told me when we weren't recording at the very beginning. While you were at Ames, you were instrumental in getting the History Office up and running again, or for the first time. Could you just give me a few details about that, and what you did, and why you thought it was important to do that?

HUBBARD: Yes. To my knowledge, and this probably should be fact-checked. I think when I was Director that I created the first Center-level History Office. That may not be completely accurate, but I know we didn't have one at Ames. We had people who remembered history. We had things that had been sent off to a repository called Camp Parks. But I was aware that we had a bunch of retirements, we had a handful of people still around that remembered the Pioneer missions, some of the early space programs, the creation of the Center moving from NACA [National Advisory Committee for Aeronautics] to NASA, and that we were about to lose, not only retirements, just living. We were about to have these people pass away.

I would see things that were really important artifacts of the past, when new space was needed they would just be taken down, plaques and models and awards, taken down off the wall and shoved in the closet or maybe, worse, after they'd been photographed just put in the dumpster. I thought that the Agency had been around long enough to develop a history—NASA

is all about exploring the future, exploring space—but that there were some important lessons to be learned there and some accomplishments to be acknowledged.

I had my CFO find a little pocket of funding that we could use to hire an archivist, to help pay for the Historian who had written one book, maybe two, about the history of Ames. Had a guy, Jack [John W.] Boyd, who'd been around forever, and also very interested in all of this. I said, "Jack, help me put a History Office together." "Right, yes, let's do that." He helped very much make it happen. I believe the archives are still there. I visited them not long ago. The current Director, Eugene [L.] Tu, says they will maintain it for the future, which I hope to be the case.

JOHNSON: We hope so too. Obviously I think history is important, but it's interesting to get other people's perspectives like yourself. It's nice to hear that other people think it's important and it should be preserved, so that's what we're working towards, that's for sure.

HUBBARD: You're doing a great job. I hope it continues. Those who do not learn from history are doomed to repeat it, they say. I would not want to be in a position where you say, "Well, gee, yes, I remember that spacecraft, that discovered the first evidence of planets around other worlds," I'm talking about Kepler [spacecraft] for example, or my work with Mars or Lunar Prospector. "Gee, I don't know that we ever saved any of that stuff." I want it to be saved, and so that's why I did it.

JOHNSON: Again, we appreciate that for sure. Is there anything else we haven't talked about that you wanted to mention before we go?

HUBBARD: I think I'm about done in here. A lot of history. If I get triggered in my brain when I look at the transcript I'll make any necessary edits. But I think we've covered it.

JOHNSON: Okay. I appreciate it.

HUBBARD: I appreciate you and NASA Headquarters funding this and being willing to record a little of these voices from the past.

[End of interview]