

**NASA HEADQUARTERS ORAL HISTORY PROJECT**  
**ORAL HISTORY TRANSCRIPT**

A. THOMAS YOUNG

INTERVIEWED BY REBECCA WRIGHT  
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WRIGHT: Today is June the 10<sup>th</sup>, 2013. This oral history interview is being conducted with Tom Young in Greenbelt, Maryland, for the NASA Headquarters Oral History project. Interviewer is Rebecca Wright, assisted by Sandra Johnson, and we thank you so much for coming in today.

YOUNG: My pleasure.

WRIGHT: We know you have a busy schedule, and it certainly started out early this morning. We'd like for you to start, if you would, by sharing with us how you first became interested in working with NASA.

YOUNG: I went to engineering school, University of Virginia [Charlottesville, Virginia], and about the time that I was graduated and leaving was really when a lot of the human space flight part of NASA was becoming active. There clearly was an interest. I hear a lot of people say, "Oh, I read science fiction and I wanted to do it all my life." That wasn't me, and I didn't. My idea was, get out of school, and one, get married, and two, after my wife finished at [The College of] William & Mary [Williamsburg, Virginia], was to go back to graduate school. I got out and went to work on hydraulic systems for nuclear submarines at the nuclear shipyard until I went back to graduate school. A friend of mine worked at [NASA] Langley [Research Center, Hampton, Virginia]. My last year at University of Virginia, I took a course where we used a

digital computer, the first one they ever had. He called and said they had a need for someone who had seen a digital computer before in their life, and was I interested in coming over?

I said, “Sure,” and that’s almost how it happened. I guess I even go back a step beyond that. I did interview—when you graduate, the interviews for jobs. There was somebody from NASA there, and I still remember when I went to talk to them. I don’t remember who it was, and it’s probably good I don’t remember. They said, “Well, there are really not any openings at Langley that you’d be interested in.” They said, “[NASA] Goddard [Space Flight Center, Greenbelt, Maryland], it’s just a bunch of longhairs there, you wouldn’t enjoy working with those people.” That’s when I abandoned looking at NASA, and then reverted largely because of a contact with a friend. Then, I never went back to graduate school, I was having so much fun. I did go off to MIT [Massachusetts Institute of Technology, Cambridge, Massachusetts], but for a business activity. It was a great decision.

WRIGHT: Tell us about some of the first projects that you worked on. I understood you were involved with Project Vector?

YOUNG: Yes, first thing I did was a small sounding rocket program called Vector, which had an active control system. In fact, it really was to look at using rotating solid rockets to control the rocket, which was looked at as a possible control system for the big solid that was being thought about by NASA at the time. Worked on it, as I said, small project, small budget, small number of people. Looking back, most of the people who worked on it went off and worked later on some of the big space projects, which is kind of interesting. Probably you don’t want to spend a lot of time on that, but an observation. In fact, I gave a talk at Langley one time on the subject.

But, the University of Virginia trained me in the academic aspects of being an engineer, but NASA really made me an engineer.

Working on the sounding rocket program, Vector, as you mentioned, was the name of it, we really did everything. We did a trajectory analysis, we did the loads analysis, I built a large, six-computer program, using analog computers actually to analyze the control system. Tremendous amount of hands-on experience, and it was a part of an activity at Langley, at the time. There was a division, when I got there, it was called AMPD, which was Applied Materials and Physics Division. It previously had been named PARD, which I guess was Pilotless Aircraft Research Division. The division chief, who had left just by the time I got there, was Bob [Robert R.] Gilruth. Branch heads and section heads were people like [Joseph Guy] Thibodaux and the Manned Spaceflight program principals. There must have been, I don't know, a dozen or 15 projects like Vector going on at one time. It was a pretty booming place.

I'm coming around to something that I think is important to NASA even today. PARD basically was invented because Langley, doing largely aeronautics work, not space work at the time, had run out of some capabilities with wind tunnels and they really concluded that they needed—particularly for transonic and some other flight regimes—they could fly sounding rockets at Wallops [Island, Virginia] and out of that, could get the aerodynamic data that they needed. One of the people heavily involved was Chris [Christopher C.] Kraft, so most of the people who people know about that really made the early days of the [NASA] Johnson Space Center [Houston, Texas, (JSC) formerly Manned Spacecraft Center] successful really came out of this division, out of PARD.

I've always thought, isn't that strange that so many came out of that activity, one, and secondly, in reflecting back and in talking somewhat to Kraft about it, the other question that you

have is these folks that really made the human space flight system so successful, including Apollo, what was the basis for which they developed their capabilities? I argue it really was out of that sounding rocket program.

At that time, the NASA folks did everything. We had no contractors that worked on the team, not that there's anything wrong with contractors because I've been one of those, too. I don't know if it was intended to be, but it really was a development kind of activity. I'm convinced that the Johnson folks, that's where they got their expertise, from Gilruth to Thibodaux to Kraft, and you could keep naming on and on and on, the people. It's a part of NASA history which maybe we've a little bit lost sight of.

WRIGHT: You didn't have any inclination to move towards the Houston crew, when they were starting to pull more and more people out of Langley to send to the Manned Spacecraft Center?

YOUNG: No. Actually, they were still there at the time because the Space Task Group was on the other side of Langley and to tell you the truth, I don't know I thought about it one way or the other, to be absolutely honest about it. The Space Task Group had been set up, and when I was there, the original seven astronauts were at Langley. It was an exciting time, with a lot going on.

WRIGHT: I know you were busy working on other projects as well. I think the Lunar Orbiter Project you started in the mid '60s?

YOUNG: Yes, after Vector, I went to work on the Lunar Orbiter, which was an interesting experience also for a young engineer—and I really was young, at the time. Actually, the guy

who had been the section head where the Vector Project was had gone over to Lunar Orbiter, and he asked me to come over. I remember thinking about it and trying to figure out what are the pros and the cons of doing it? I met with my branch head. I still remember what he said. He said, "If you're good here, you'll probably be good there, and if you're not good here, you probably won't be good there." I've never quite figured out where that fit in, but it must have been profound enough!

WRIGHT: It stayed with you.

YOUNG: I sat down with a piece of paper and I said, "Okay, what are the pros and what are the cons?" I wasn't very good at that because my thoughts were, "Good gracious, that's a big space project. I mean, somebody could really fail there." I really concluded, you will never be satisfied if you didn't try it, so I went to work on Lunar Orbiter, which was a fantastic experience. I had an enormous amount of interaction with JSC at that time.

WRIGHT: You got pretty much a responsible role. Didn't you start to define that?

YOUNG: Some of it was just because of filling vacuums. In fact, that was true of NASA in those days. There was really so much going on. Most people were working beyond their experience level, beyond their age level, which was terrific, but not without good leadership. I'm deviating a little bit, but there was a lot of latitude to do almost anything you wanted, but on the other hand, there was sufficiently really good leadership that you might fall, but you weren't going to fall very far because somebody's going to help you in the process.

Lunar Orbiter, how old was I when I started Lunar Orbiter? I guess that was maybe '64, so I was 25, 26, something like that. The basic purpose of Lunar Orbiter was to photograph the areas on the surface of the Moon to provide a landing site for Surveyor and Apollo, and more operational than science. There was nobody at Langley knew anything about the Moon, other than looking at it at night. Langley was not a space science organization, so we weren't overwhelmed with a lot of space scientists.

My basic job was doing mission analysis kinds of work, working for a guy named Norm [Norman] Crabill, who encouraged people to go beyond their limits. There were many big issues—obviously, how to build a spacecraft and operate it—but a big item was the Moon and landing sites. There really was nobody to deal with the U.S. Geological Survey, the Gene Shoemaker operation in Flagstaff [Arizona], and the people at JPL [NASA Jet Propulsion Laboratory, Pasadena, California] who were doing Surveyor, and the people at Houston who were doing the Apollo stuff. I really got to do those kinds of things at a very young age, so I basically, with a lot of other people involved, had a first-hand involvement in picking the sites that we photographed and learning something about the Moon, which was interesting. Going to [NASA] Headquarters [Washington, DC] and selling the mission to Sam [Samuel C.] Phillips, who was running the program at the time. Interacting, as I said, with the people in the other organizations.

It was a pretty interesting time, and it wasn't unique with me, but people just had an opportunity to really function, I guess, way beyond what any formula would say they should be allowed to function at. I then went to JPL, when we did the operations, worked with Boeing, who is the prime contractor, doing the operations, really doing real time adjustments to taking pictures. One of the interesting circumstances that we had was that we noticed that the

spacecraft, the pictures were not always pointed exactly where we wanted the pointing to take place on the early ones. It was because, finally, we began to notice that the Lunar Orbiter spacecraft, as it went across the Moon from the eastern side of the Moon to the western side, going towards the center, it would speed up. Then, going towards the other side, it would slow down. We were not smart enough to figure out why. We recognized it and we started using Kentucky windage to adjust the sites, which worked very well—but it was the mascons, it was the mass anomalies on the Moon that was causing it. As I said, other people really figured out what it was, but again, a good, interesting experience.

We were more operational, so we weren't so much trying to figure out what it was as what was really going on, so that was an interesting experience. I don't know why, but because of this particular activity, I had a lot of interaction with the press and with the media, so I was involved in it, which was interesting. In fact, at that time, Langley had its—must have been its 50<sup>th</sup> anniversary, I don't know—I remember they had a big open house and I spoke at the open house. My speech was carried through the Lunar Orbiter spacecraft, like we are, but they came through. Because of the round-trip time, it was one-and-a-half seconds each way, if I remember right, I think it was a three-second total delay. It was an interesting process.

I'm really rambling beyond what you want, but it was a really interesting process in that as the speaker, I could hear what I said either one-and-a-half or three seconds before. It was a real experience, trying to learn how to talk when what you said, some one-and-a-half to three seconds earlier, you were hearing that while you were talking the next activity. I later found out that apparently, they used that technique, I think, in the military draft in World War II. People who claimed that they were hearing-impaired or what have you, and then if you did that and you weren't prepared, you would trip up in what you were saying. Lunar Orbiter was a fantastic

experience for a young engineer, and really pretty exciting times. A lot going on, and I got to know and work with all the people that you read and hear about these days.

WRIGHT: You had no way to look in the future, but a lot of the places that you would go to work and be contacting those people, in the future, you started laying some of that down—

YOUNG: Yes, it's a network, it does develop. I guess that's probably true in any circumstance, there's such a thing that exists, yes.

WRIGHT: You moved into Advanced Space Projects, and actually helping to develop some Mars missions. Was that your next assignment?

YOUNG: I'll tell you just a couple more things on Lunar Orbiter which just strikes me. First off, there were five spacecraft, and all five worked, which was exciting. If I'm not mistaken—this was way beyond my involvement—I think when the contract was signed with Boeing on the Lunar Orbiter, the first spacecraft was in orbit about the Moon only 27 months later. If you think about today, we haven't completed phase A in that time period. There just was a lot of motivation to move on, and you can do these things a lot faster.

The other thing I remember was dealing with the people on Apollo at Houston; they had a focus that they couldn't allow anything to get in the way. I remember their comments—which I think were right on—they said, "Look, you should know the following: we don't need you, and we'll never say that we need you. Now, if you provide some data, we're going to be delighted to have it, but we're going whether you're there or you're not there." I actually think that was the



right way for them to function, but it was an interesting perspective. At Langley, or if you went to JSC or JPL, anywhere the activity was going on, it was just a beehive of activity, that's what I recall. Everywhere you went, there were meetings and things being decided and moving on towards accomplishing goals, which was pretty interesting.

After Lunar Orbiter was over, I guess the powers that be were saying, "All right, what now," for the people that were there. I guess that was the first, relatively speaking, large space project that Langley had ever done. I really come back and say they did sounding rocket programs and a lot of activity in that regard, but relative to the so-called larger space projects. JPL had always been the organization that had done both the lunar and the planetary programs. I guess—and I don't even know this, by the way—JPL was doing, at the time, Ranger [Program], and it had some challenges, and they were also doing Surveyor, which was a very demanding program, and probably the leadership of NASA—and I'm beyond my knowledge—would probably say, "Well, maybe we need somebody else involved," and that's how the Lunar Orbiter got done at Langley.

Then, after that, there was the Advanced Projects Office had put together a few of us, worked in, and we looked at a few possibilities. Landsat [Satellite] kinds of programs were looked at, then there really was coming to be in the Mars activity, there had been really a large Mars program that had started but then decided not to proceed, and again, I can't recall exact details. There really was some look at what really should be done next on Mars. JPL was doing the Mariner series, which was not only Mars, but the Mariner series. I guess there was Mariner 4 that was happening, and then Mariner '69, which must have been 5 and 6, and then Mariner 8 and 9. JPL was doing the Mariner series, and Langley was asked, again, beyond my level of involvement, to look at a mission that had a lander.

Again, for somebody like me, still pretty young in the process, I think there were three of us working on it when we started. Jim [James S.] Martin, who became the project manager and was one of the most impressive managers with whom I ever worked, and Iz [Israel] Taback, who was the Chief Engineer extraordinary, who was the most impressive systems engineering folk I ever worked with, and then they had to have somebody, so I was the somebody, I guess. Began to do little studies of it, and other people, largely from Lunar Orbiter heritage, got involved, and so it became a fairly active process. We had a collection of studies done by the folks in industry that had some expertise in that—Boeing had a study, Martin Marietta, General Electric, who was doing, at that time, GE had an entry capability in Valley Forge [Pennsylvania]. There were a lot of studies, so we really looked at a large collection of options as to what was the best way to go to Mars.

Finally, had a Saturday meeting with John [E.] Naugle from NASA Headquarters, and John was the head of Space Science, whatever it was called at that time. John was the senior folk. Ed [Edgar M.] Cortright was the Director at Langley who was another just incredible person. If there's any message I'll give you out of all this, the greatest advantage I've had is just working with super people. If you work with super people, you can't help but learn something in the process. We had a Saturday meeting to present the results of all of our studies, and to begin the process of deciding what really should be Viking.

I remember several things about that day, and I'll tell you what some of the options were, and I'll tell you what we recommended and what really happened. The first thing I remember was John Naugle came in and it was Saturday and he said, "Well, I don't know if this is a good omen or not, but the flag outside is upside-down." When the guard put up the flag that Saturday morning, he got it upside-down. That was more humorous. The big issues were, is it a hard

lander or is it a soft lander, is it a short-lived lander or a long-life lander? “Hard lander” meaning the big balsa ball and it hits, and then the ball breaks open, and the Russians had used that concept.

The lifetime was should it be three days or multi-months? Then, the question was, should there be an orbiter with it or should there be a flyby module that is the mother ship on the way to Mars and then the lander separates and lands? By the way, our knowledge of Mars at that time was incredibly poor. We knew little about the atmosphere, which was critically important, and the smallest thing we had seen on Mars was about the size of the Rose Bowl. That was the level of knowledge that we had at that time.

As I remember, we recommended that it be a soft lander because you could do so much more science with a soft lander, be a long-life lander, meaning months, which meant that it had to have radioisotope thermoelectric generator power or nuclear power, which was an interesting twist at the time. We said a flyby module, no orbiter. It was a great meeting, and again, for a young guy to sit and watch. Went through the whole process for the day and the Headquarters folks took it all in and went back for their discussions there. It went to the Administrator at the time, Tom [Thomas O.] Paine, and kind of interesting—as I said, the concept being pursued, somewhat budget-driven, technology-driven, was a flyby support module with a lander, like Viking ended up being. Paine changed the recommendation, and he added an orbiter to it, which is pretty phenomenal, if you think about it today. The word was that the reason he did it was that he said, “You don’t do these things very often, and when you do them, you should really do them right.” That had a lot of implications because—and by the way, it was incredibly the right decision in retrospect, and I’ll come to that in a minute—if you think, again, messages to an

organization, and I'm using myself, the Administrator says, "Hey, we really need to do this right and we want to do more than you're recommending, not less than you're recommending."

That was a pretty powerful message. The other implication it had was we had no launch vehicle that was compatible with that, and it really meant that the Titan-Centaur had to be developed. Titan existed and Centaur existed, but it really meant that you had to bring online a Titan-Centaur launch vehicle to do the program. I'll jump ahead. That was an interesting experience in itself, but it happened that because the Titan-Centaur was developed, first a joint program with the German's Helios—if I remember right, was the name of it—flew on the Titan-Centaur, but equally more important, Voyager 1 and 2. I don't know, for Voyager, that a vehicle would have been developed by itself. It facilitated that program happening, so it was a pretty significant decision.

That happened, and we were off and running, and then we were aiming towards a '73 launch. Then, congressional budget activities resulted in the launch being changed to '75, but '75 was what we went to for a landing in '76. I want to talk about some of that in a bit, but it was two things, when I look back on it, that I didn't appreciate at all. One is I didn't appreciate what incredible people were working on the program. I knew they were good, but I didn't really appreciate how much above norm they really were.

The second thing I really didn't appreciate, even in the middle of it, what an incredibly difficult thing it was. That was about as hard a thing as you could do from a robotic spacecraft standpoint. Almost everything was new; the systems were new on the spacecraft. We had something called a plated-wire memory computer, where the memory really is plated wires about the size of a human hair. That almost brought us to our knees. The spacecraft had to be sterilized because the international agreements on not contaminating Mars with Earth life. That

meant that ultimately, after it all got put together, the spacecraft at the Cape [Canaveral, Florida]—there were special ovens built—and the spacecraft was baked. I think—I'm really pulling numbers out—it was 113 degrees centigrade, which is pretty high, for more than a day. That meant that the tape recorder had to have metal tape for the recording of the tape recorder; it meant everything in there had to be sterilized, which was something that we had never done before.

We also had an organic experiment, so there had to be no organics that could be released on Mars. These were special items. The atmosphere was such that we had to have a supersonic parachute, which we had never developed. That's kind of a pretty interesting side thing in itself, that Langley, because of its aerodynamics background, really developed the parachute system in parallel with the Viking Project. Viking oversaw that, but there really was a team of people at Langley that were heavily involved in the entry systems. Almost everything was new, and plus the fact that, if I remember right, a 10-inch rock could punch a hole in the bottom of the spacecraft, and the smallest thing we had ever seen on Mars was, like, the size of the Rose Bowl.

These were pretty incredible times, and it just took incredible people to make it happen. I learned a lot in that time period, which I think is applicable today. What made Viking successful clearly was the incredible people, both in NASA and industry, and it was really the partnership between the two. The industry could not have come close, in my view, to having done it by themselves, and NASA couldn't have come close.

That partnership we had, in the project team, experts in every element of the system, and they worked hand-in-hand with their industry counterparts. One relied on the other. Then, when we got to the operations and flight missions, we now had to operate this thing, and it was pretty sophisticated. In fact, operations beyond anything we had done before. I guess I've left myself

out, but I went through various phases on the program, and in fact, left it, even, for a year because Jim Martin and Ed Cortright concluded that I could benefit by going to MIT for a year as a Sloan Fellow. That, again, was a fairly significant message to somebody like me, who didn't think I was the most important person ever, didn't think I was a contributor on it, and they said, "Look, we think the most important thing for you to do is to go to MIT's Sloan program for a year," which was quite an experience. One of my classmates was Kofi Annan, who became head of the U.N. [United Nations]. Different folks like that. We used to have dinner together regularly.

Again, a great experience, and it shows a little bit of what NASA was all about. That really was Ed Cortright and Jim Martin. I'll say one other item, just touching on that, when the year was coming to an end, people who were in the program from IBM, they maybe started at a particular level and they were being promoted to vice-president to go somewhere, and a good friend was going to this. Jim Martin said, "Hey, look, you're going to come back to the same job you left. If you've learned anything and you're any good, you'll go beyond that. You're not going to get promoted because you went to school, you're going to get promoted because maybe you learned something and you can do something better."

WRIGHT: Because you applied it.

YOUNG: That was pretty good, too. I've used that a lot in my life since then, to tell other people. When we got to preparation of the operations, we were having a lot of struggles. I became head of that activity. We did another bold thing, which again, was Cortright and Jim Martin and Iz Taback. We had prime contractor, who was Martin Marietta, and we're not satisfied that this

was something that they had the experience and the background to do, so we changed the contract. We made them a time and material contractor and we took total responsibility for the operations. Some people were saying, “Boy, that’s a crazy thing to do. You’ve relieved the contractor of that responsibility.” But again, people like Jim Martin had courage to, obviously, do what they considered was right. It probably wasn’t a politically-smart thing to do, if somehow we had screwed it up.

His criteria was simple, and that is, you just have to take what you think is the best you have and most capability you have to do it. We took it over and ran the activity with JPL very much a part of the activity—because they were responsible for the Orbiter—and the Martin Marietta people, the Lander, but we from Langley ran the activity. We were the so-called prime, so we weren’t monitoring, we were doing it. Again, if you look back, that probably took some courage, it was somewhat bold, and that’s what outstanding program people do, is to make those kinds of decisions. I remember we were struggling with some of it and we got some help from Houston. We went to Houston and said, “Hey, help us learn to operate these big space programs.” Goodness gracious, probably he’s dead now so I don’t know if you ever interviewed him or not, he headed a lot of the software activity at Houston.

The Houston folks designated him to lead some reviews for us, and he did, he was extraordinarily helpful. We learned about a Houston technique, which you may have come across in your stuff, called Black Friday. Black Friday was where things were about to fall apart, so instead of going home on Friday, you lock the doors and say, “We’ve got to simplify this so the human beings can handle the situation.” He helped us do that. We got a lot of help from everywhere, I guess, is what I’m saying.

In the operations, we had the launches, there was a group of us on the West Coast which I headed up; a group on the East Coast launching this stuff. Went pretty well. I want to stop there, so if you want to ask questions, because I'm going to now talk about the operation and I don't know if I've missed something in the process.

WRIGHT: No, because you're filling in the blanks. I did want to make sure we got what you did, so this is exactly where we wanted to go.

YOUNG: I guess if you would go all the way back, I was originally, on Viking, I was something called Science Integration Manager—that's because they couldn't figure out anything else—but what I basically did, I was the go-between, between the scientists and the engineers in the early days of the project. Then, I did mission analysis, definition work, then headed the operations. Then, I was Mission Director for the program, and we had a Flight Team; we had about 800 people in the Operations Team.

All the scientists were required to be there all the time, and it was a 24-hour operation, obviously. Not any different than other places have, but for a pretty long duration. In fact, I remember, again, the people at Headquarters, there were a couple of problems. One is there had not been a mission, maybe, of that duration before, so they were really worried whether or not we would crumble under the stress of it. The other was Mars is different from Earth in that the day is a little longer than an Earth day, and we call Mars days sols, and what that meant was the time for all the operations on Earth kept rotating a little bit every day because you really had to be on lander time, so to speak, or on Mars time.



There were a lot of people who thought that probably people psychologically couldn't handle that, and so, actually they set up medical teams. I think the real answer is that for a given amount of time—and this cannot be infinite, but it was okay for what we were talking about, which was the first landing was in July and then the nominal mission really ended in November, that was the critical time period. You might say when the orbiter got there, it was in June, but it was a six-month activity. For that amount of time, adrenaline will carry you, the excitement, the motion, whatever you want to do will carry you. I don't think there was ever any real—the concerns were not justified. Now, I think if something goes on like missions today, that go on and on and on forever, then I think that is a real factor to be considered.

I'll back up again. When we launched, we did not fully know how to operate the lander on the surface. The lander was very sophisticated, the software was sophisticated, and we really had not worked out how to operate the lander, I guess. In fact, we used to somewhat joke and somewhat serious, we said, "We're not quite sure whether this thing is an obedient robot or a Frankenstein in the process." The idea was that there's a long cruise to Mars, so it's a lot of time to do work, so we would really work that out on the way to Mars, which was fine. There was no reason not to do that. We did learn something very quickly. As I said, I was Mission Director, and Jim Martin was clearly the senior person, as the Project Manager.

In the early days of the cruise to Mars with the two systems, we found that we weren't really getting the work accomplished that was necessary for when we got to Mars, the reason being every time there was a little problem, if the battery had a little bit too high a voltage or the temperature was a little high or a little low, everybody went to work on the problem because that was the problem of the day. The problems that occurred didn't require everybody to work on them, but you just gravitated to them.

A real decision was made to separate the flight team, and the idea was to take one group of people and say, “You go prepare for when we get to Mars,” and another group of people, we said, “You fly the spacecraft to Mars.” I was given the responsibility of heading the activity of getting ready for when we went to Mars. We actually moved out of the Operations Center. We stayed at JPL, but we went to different facilities. That decision probably was one of—well, there are a lot of good decisions that Jim and his people made—but that was a critical decision because when we got to Mars, we were ready. We had done all the training, we’d planned the sequence, that we were ready when we got there. We may not have been ready if we hadn’t have done that.

We’re approaching Mars, and we had an interesting circumstance, in that the propulsion system on the orbiter had a helium tank and then the propellant tank, I guess you could say. Helium tank pressurized the propellant tank and forced the propellant into the engine, to fire the engine. We had a helium leak that developed as we were approaching Mars. If you looked at the data, what happened, the helium was leaking in the propellant tank. You could see the pressure build up, and it was pretty clear that before we got to Mars, it was going to explode. That really wasn’t controversial. The question is, what do you do about it?

There were really two big options to do. One was there was a pyrotechnic valve that you could close that would shut off the leak, but then it had to open in order to be able to get into orbit at Mars. If it didn’t open, the mission would be a failure. That was one option. The other option was periodically do small mid-course maneuvers, burn the engine periodically, to reduce the pressure. That clearly would work, but that put an awful heavy workload on the operating team because you had to continually regenerate the commands and doing the operations to do that. It was a heavy workload on the work team, opportunity for making a mistake, but you weren’t vulnerable to a valve having to open in order to have a successful mission.

Lot of discussion about it. The valve was put there, by the way, for that purpose. I remember, at the final decision meeting as to what to do, the large majority were in favor of the valve solution. I think there were maybe three people—there was a small number of people in favor of the workload decision. The decision was a Jim Martin, Project Manager decision, and we did the workload decision. There were two logics. One is, much of what you're doing in even space missions and in operations, consensus is probably the reasonable solution to the problem, but when it's life and death, consensus doesn't have any role. Some accountable person has to make a decision, and that accountable person decided to go in the direction that the minimal number of people supported, simply because it was his view that you should not put yourself at catastrophic risk of having to have the valve open. He trusted the team more than he trusted the valve, I guess, would be the way to say it. What a great learning experience, with that.

Then, we did that. It worked, and we went into orbit. We had a pre-selected landing site that we had selected more than a year beforehand, maybe even two years, in fact, because I chaired the landing site selection process, which I'll tell you a couple of interesting tidbits on. We went into orbit and we had prepared ourselves to validate in a collection of ways the landing site after we got there. Our plan was to land on July the 4<sup>th</sup>, 1976, a rather significant day. It had been advertised everywhere that we were going to land on the bicentennial anniversary of the United States. It was not insignificant that that was the plan.

We had set up a ground telescope capability in Arecibo, Puerto Rico, that could look at the area at about the same time as we got there, and give us some indication of roughness, and then we had cameras on-board the orbiter that were better than anything that had ever flown before. When we got there and we got our first looks at the place we were going to land, the

indications were it was a lot rougher than we had thought it was. Quickly, we abandoned the landing site and abandoned landing on July the 4<sup>th</sup>.

Looking back on it, that was another fairly significant factor—because I remember the process when we decided that—we never hesitated one minute to abandon July the 4<sup>th</sup> for the safety of the mission. It didn't play a role one way or the other. People from the leadership, from NASA Headquarters in the East, they were involved, many of them were there, informed, but it wasn't a decision we asked anybody about. We made it and we did it because as far as we were concerned, it was clear. Then, we went about searching for a site, and we didn't have an awful lot of time because we had another spacecraft coming right behind it, so we had to get on the ground before the next one got there because we could never have operated them both simultaneously. That was, again, an interesting learning experience.

We picked a site, landed, and fortunately, we were successful. Not too far from us was a rock—if we'd have landed on it, it would have destroyed the spacecraft. You could see it sitting there, and there wasn't anything we could have done about it. It was just—I started to say “luck,” I don't know. I remember a press conference, one of the press people asked Jim Martin—Jim and I were both doing the press conference—if he believed in luck, and Jim said, “There's no such thing as luck.” He was that kind of person. They asked me, I said, “Look, I don't believe in it, but I'll take all I can get.”

WRIGHT: Just in case.

YOUNG: An extraordinary mission. The press involvement, it's worth spending a minute on, if somebody might read this part of it. We—again, I'd say that Jim was the motivation behind it—

went out of our way to be open, transparent with the media. We had a press conference every day for the activity and we both discussed science, but also engineering. There were problems that came up; we told about the problems when they occurred. We told them, “We don’t know the answer, but we’ll tell you as we went along.”

Two things came out of that. We were searching for life, obviously, and really exploring the unknown, and two things happened. One is the press really got enamored with watching the scientific process work, and most of them who had planned to go home after three days stayed for the total mission. I’d say we had almost everybody there for the total mission, although maybe some of the network stars for the whole time, which was pretty interesting because they got to see the scientific process work.

The second thing that I learned out of it was we eliminated the investigative reporter. There was no role for an investigative reporter because there wasn’t anything to investigate. As I said, we were extraordinarily open, as a policy, but we did have a rule, and that was if you were involved in a press conference, no matter who you were, you were not allowed to speculate, but you could tell any fact that existed. Don’t speculate until you really know something. That’s carried me a long ways, in the rest of my life. I’ve treated that—way ahead of my story, I worked with one other individual who taught me, a guy named Norm [Norman R.] Augustine, who taught me one other factor about dealing with the press, which I’ve used ever since and I use today, is, never do anything on background. If I interact today, testifying, if I interact with anybody, my comment is, “Anything I tell you is on the record.” If I’m not willing to be quoted, I really shouldn’t say it. I think that’s, again, another important factor.

WRIGHT: Contextually speaking, when Viking, when you were working on that mission, the manned programs had concluded, Apollo had closed down at the end of ASTP [Apollo Soyuz Test Project], and we were also post-Watergate [political scandal]. It's interesting, you talk about the transparency of what you were doing, and then I'm sure they were hungry for space missions, and so it was a good opportunity to show the science side of what NASA does as well.

YOUNG: I'm sure that's right. As I said, we went from not seeing something, as I said, any smaller than the Rose Bowl to being able to see a blade of grass. There wasn't any grass, but you know, see something that size.

We had extraordinary people on the program, extraordinary scientists. I remember—and I want to be careful I say this right—when we were picking the site after we got there and abandoned the site, I remember one night with Carl Sagan, and Carl made a comment, “I have to be very careful what I say because you all are listening.” You learn from that, too. If somebody's not listening to you, you can say anything you want, but if they're really going to process it.

After we landed and we operated, another interesting aspect, when we were doing the planning, the imaging team leader was a guy named Tim [Thomas A.] Mutch, who was a pretty incredible person, who actually shortly after the mission was over died mountain-climbing in the Himalayas. I shouldn't say “shortly after,” it was maybe two years, three years after that. We put together a pre-planned sequence of images that we could take on maybe the first 7 or 10 days, and what we would do each day, in case we did have an early failure or in case we couldn't get commands into it.

We had a pre-planned program that was ended for the images, and I remember when we were planning that, Tim and some of us were advocating—I was, others—that we had a picture of the American flag on a top of the piece of the structure on the lander. I can't remember what it was, but maybe the fifth one or something like that was a picture of the American flag. We were doing the planning, and Tim Mutch, who was the head of the imaging team, was against it. He thought all the pictures should be of Mars, and that's certainly a worthy idea. We were, I don't know, a few weeks into the mission and he called me one day, his office was in another building at JPL, and he said, "I need to come over to see you just for a minute."

So he came over. We had been friends forever. He came over and he said, "Look, I just got to tell you something." He said, "I was sitting at my desk and I happened to look at the wall at my desk, where I put notes and stuff," and he said, "I only had one picture up there—it was the picture of the American flag. I just wanted to tell you that maybe that was an important thing to do after all." Which is, again, an interesting story because you do these for a lot of different reasons. Science is a fundamental reason, but there is a human prestige and what have you.

WRIGHT: While you were talking about the operational aspect, I was thinking about how you started, as you mentioned, as an engineer, but now you're encountering all these scientists. Reading about research in planetary programs and Earth science, all of those, there's a mixture of science and engineering. Can you share with us how that chemistry has to be so right to make that mission work?

YOUNG: No question. I think that that mixture is important. Most of the robotic programs, in particular, really are science missions that are enabled by engineering. There's got to be a strong

degree of understanding and respect of the engineers for what the science folks are trying to do. There's got to be a strong appreciation from the scientists and trust that the engineers are going to push the limit but not go beyond the limit of risk to the mission. Not only that trust, but that mutual understanding, I guess fortunately these things take a few years to develop. That really develops over time.

If I'd use myself as an example, I am not a scientist, but I have developed a lot of appreciation for science activities and I actually have done a lot of things in that regard which we'll probably get around to. Most of the good scientists had a high regard for the engineering activity. I think you really touched on an idea. These things would not happen if it was not that cross-pollenization. It really says that engineers, you don't have to become world-class scientist, but you've got to become a scientist at some level to be able to really understand the communication, and vice-versa.

For me, personally, just happenstance, luck, or what have you, but as I mentioned, back on Lunar Orbiter, I really was the guy in the project who worked with the scientists, simply because there wasn't anybody else, not because of any great ability. These folks who—I don't know whether names mean something to you all or not—Gene [Eugene M.] Shoemaker and Hal [Harold] Masursky and these guys, I used to spend days and weeks with these folks, doing that. They'd visit my house when they were in Langley, and vice-versa. It somewhat rubs off on you, and in both directions. Then, started off on Viking, really being that interaction.

I think it is critically important that the trust and the mutual understanding really be there. If the scientists think that the engineering side is trying to too much make their job—the engineering job—easy, or they're being too conservative with risk, that relationship will break down. On the other hand, scientists have got to recognize that when someone with a deep



engineering knowledge really draws the line, they've got to be supportive of that. I would say on the two projects I really was heavily involved with, which was both Lunar Orbiter and Viking, and particularly Viking, that really was true. That mutual support, respect, was there.

WRIGHT: At times do you need that conduit, a person like you, who is kind of in the middle to bring them together or to help work those out?

YOUNG: I think so, yes. I think that conduit does help, but it's really got to go through the organization. I've talked a lot about Jim Martin, who's kind of my hero, as a project manager. Jim was about as hardnosed a project manager as you can imagine. His focus on success could almost be brutal, and I mean that complimentary, but he had a strong recognition of how important the science was. I would say, with Jim, ties typically went to the scientists. I don't mean that if it was clearly the right engineering decision, it didn't go, but if there was a tie, the tie went to the scientists. That's the way it should be, by the way. I think when we landed on Mars the first time, there was clearly enormous euphoria, but I think there was a big respect that the mission was just starting, not ending. Sometimes, you see missions when the enormous engineering feat has happened, there's this feeling that it's gravy from that point on, but that's not the attitude that permeated Viking and permeates most, I think, of the robotic programs, but really critically important.

WRIGHT: It seemed like the Planetary Program became your path for a while. I believe you went to become the Director of the program for that?

YOUNG: Yes, when Viking was over, when the nominal mission was over, there was one really great thing, and that is when the Earth and the Sun and Mars line up, you can't communicate with Mars. It's called a solar conjunction. The one we encountered was on November the 15<sup>th</sup> of '76, and that was the end of the nominal mission. Those of us who really were committed to carry out the nominal mission—and I worked on Viking eight or nine years, and I'll touch on that, that's a point I should make in case some young person happens to trip across this—several years in advance, even assuming everything worked, I knew the last day I was going to work on the project. That was at solar conjunction; it was two weeks with no communication. There was a team that was put together to operate it in extended mission, but on November 16<sup>th</sup>, was heading east. I'm now talking about myself personally, but I guess I started on Viking, we did the advanced studies, as you talked about, almost after Lunar Orbiter and so, it was eight years, nine years, something like that, I worked on Viking.

My biggest fear was somebody would come along and figure that they should promote me or do something else there because the only thing I wanted to do was see it to the end. Not many people see projects from day one to the end. Actually, a job did come up, which was similar to the one I went to. I was asked to come to Headquarters to interview for head of the Astronomy Program—not the Planetary Program—the same kind of activity. John Naugle was still head of Space Science, and John said it in a nice way. He said that, “You won't be selected for this because I want you to stay on Viking.”

WRIGHT: You had a practice interview.

YOUNG: It would have been perceived as a significant career advancement, but I remember how I thought, “God, I sure hope I don’t get this job.” I really touch on that because I must say that both in my NASA life and in my corporate life, I’ve had a lot of people come in and say, “Well, I’ve been working on this project for two years and I’m ready to go on to something else.” And I say, “Well, let me tell you about an experience.” I don’t think there’s anything quite like seeing it from the beginning to the end. I’d say there were a lot of people who were in that category, who really had no interest in doing something else. When it was over, I’ve never been very much of a career planner, so I had no idea what to do.

Naugle had moved up, he’d got promoted, he moved up in NASA, and a guy was head of the Space Science Program, Noel [W.] Hinners was his name—I don’t know if you’ve done Noel or not, but a pretty incredible person—Noel was the head of it. It’s always been a scientist-engineering partnership, and a guy named Tony [Anthony J.] Calio, who died not very long ago, was the engineer partner with Noel. Noel asked if I would come to Headquarters to head the Planetary Program, and it took me about 30 seconds to say yes, and I went off to Headquarters to do that.

It was an interesting experience because up until that time, if you really looked, the only thing I knew was projects. People who are involved in projects have a completely different outlook on life to people who are involved in more functional or institutional kind of management. Project people, they don’t really say this, but the way they operate, it’s okay with them on the last day of the project, if all the buildings fall down, if the institution disintegrates on the last day of the project, that’s okay. Then, there’s another group of people who are trying to make the institution carry on for the next projects that are taking place. I probably didn’t say that very well.

I went to NASA Headquarters, which was an interesting experience in a whole lot of ways. One was I probably had never seen the government operate close-up so much. [President] Jimmy Carter and I went about the same time, but he didn't realize that. What I'm really saying is there was a new president, a new administration, and so it was a chance to see that a little bit closer-up than I'd ever seen anything before, and to operate in the Washington environment, which was challenging for somebody who's come from the project world, I'd say. It was a great experience, a good experience.

WRIGHT: It's a lot of different changes going on with that. Talk about some of the programs that were under your direction.

YOUNG: There were a lot of things going on. There was a big discussion as to what to do after Viking, and that's worth spending one minute on. Actually, Tim Mutch had gone back to Brown University [Providence, Rhode Island] and Tim headed this study at my request, looking at a Mars sample return. We're still looking at Mars sample returns, so some things go on for a long time. Budget environments were changing, in a less favorable—which they go through those cycles. JPL had a new director, Bruce Murray, who became a very good friend, who is a very hard-charging scientist. He came from Caltech [California Institute of Technology, Pasadena, California], and had been involved in the planetary work from a science standpoint and was eager to change the world, and the world wasn't ready to be changed. I worked with Bruce a lot. One of the early experiences was trying to understand how you deal with the budget situation, for me.

I'd say my first year, it seemed like being on a roller coaster, until you finally figured out there is a pattern to the whole process. I remember trying to do some budget priorities, and one of the things that fell below the line, so to speak, in activity was there was a seismometer that was operating on the Moon that had been carried by Apollo. The scientist was Frank Press, still have some interaction with him. Frank was the President's Science Advisor, and I decided to turn it off, which was interesting.

I come back again, though, to a lot of these things are learning experiences, and that is, you see it today, but I think somebody who has a government position like that, and that's an insignificant position compared to a lot of the things that you see in the government, but you have two roles. One is you're an advocate for the program, and so you're trying to maximize the funding for your program, and it never turns out to be just what anyone wants. Once that's determined, then the responsibility is to spend it on the highest-priority items, and the lower-priority items should fall below the line. I'm not sure we do that so well, today, to tell you the truth. The lunar seismometer fell below the line, and I think Press accepted that, even though I probably was naïve in recognizing that it was the President's Science Advisor who was the experimenter.

The program that had been started that was the main item going on at the time had not launched, was in development and going forward, was Voyager, which turned out to be an incredible success, and is even today. We were looking at starting some new programs, one of which was called VOIR [Venus Orbiter Imaging Radar], which was an orbiter around Venus. There was a lot going on, a lot of budget challenges. A new Administrator, Bob [Robert A.] Frosch, was there, and Noel Hinners, working with him was, again, a real learning experience. Noel comes out of a science background; was not a lot of management roles but has a

management instinct that just was incredibly impressive and did a great job there, and was a principled person above almost all else.

WRIGHT: You want to elaborate on the management by instinct? That's an interesting thought.

YOUNG: Yes, I think Noel Hinners—and I'd say the same thing throughout his life—I'd put him high up on the list of managers who I've interacted with, but if you were looking at his background, you would not figure out that from either experience or education, they would not be obvious characteristics that one would have. I think that his instincts were just good, and he knew how to use people, and where his expertise maybe was not as developed as somebody else's, he knew how to use that. I thought he just made incredibly good decisions and was a really good leader. I also think you watch people who are very, very bright and very capable who don't have an intuitive feel for the business or what it is they're trying to do, and they really struggle. Having instincts is a way to say having an intuitive feel for the activity in addition to being smart and capable and experience is a critical element, and I don't totally know how people get that. You can see those who have it and those who don't.

WRIGHT: You weren't there very long before they sent you back to California.

YOUNG: No, I wasn't. A chain of events happened; one is the Director at [NASA] Ames [Research Center, Moffett Field, California]—Hans Mark was the Director at Ames, and Hans was selected to be Secretary of the Air Force, and his deputy, Sy [Clarence A.] Syvertson, moved up. Sy did a search for people, for someone to be his deputy. I guess I was one of the

candidates; not something I had applied for, but Sy came and talked to me, did a systematic interview, and I think there were a lot of good people, but Sy needed someone who had some understanding of projects because he had projects that were not doing all that well. I was asked to do it, and we packed up and moved across country and went to Ames. I was there, I think, one year, and my family was there nine months, or something like that. I'll come back to that because that also was a good experience, and working with Sy was a good experience—who also died not very long ago.

Then, I got a call. Al [Alan M.] Lovelace, I guess, was the Acting Administrator at that time. Al Lovelace called up and asked, he was going to be at Rockwell, and if I'd come down to meet with him. The Goddard position was open. Bob [Robert S.] Cooper had left and gone to the DoD [Department of Defense], and he asked if I'd be interested in the Goddard job, which I obviously was. In fact, for my background, there are really two great jobs: one is Goddard, and one is JPL, just from the standpoint that my experience was more in the robotic world, and that's where flight projects is their primary business. I remember he said, "Tell your wife I owe her one." I told her that and she said, "One is not adequate."

It worked out that we were coming back, so to speak, so we packed up and came back to Goddard. Ames was an interesting experience. I don't think people often stop and think, but Ames, at the time, I think, was smaller than Headquarters, in terms of total number of people, and just accomplished an incredible amount in that timeframe. There really were some world-class people who were there who I would say took me under their wing, at the time.

I remember—again, these are the learning experiences—when I went out, it was an Ames tradition that the Director and the Deputy Director had an assistant, but it was stronger than that. It was a very competent researcher or technical person, and I remember I had this woman who

was really impressive. When I got out there, trying to show that I deserved to be there, I said, “Do you all have anything like NMIs?” NASA Management Instructions, which I’d seen at Headquarters.

She said, “Yes, we have AMIs,” Ames Management Instructions.

I said, “Could you get somebody to pull them together because I’d like to read through them.”

She said, “Why do you want to do that?”

I said, “Well, I should know what the policies are of the Center.”

She said, “All it does is tell you what you can’t do—why would you want to know what you can’t do?” She said, “I recommend you not read them,” and I never did! I don’t want to get carried away with that because policies are important, but there was an interesting message she was giving, “Don’t come out here and write off, spend all your time trying to understand what you can’t do. We need help.” I remember that quite well.

Sy was interesting, in that he, relatively to projects, pretty much said, “Hey, they’re yours.” There were some space projects but also some aeronautics projects. I was there a year, so at my retirement dinner they said, “We hardly knew you.” In fact, it wasn’t really a total year because towards the latter part of it was when—which is an interesting step in my evolution or what have you—Shuttle had run into a big problem in Washington, which I’ll talk a little bit about. Lovelace put together a small group of people to do an independent review of Space Shuttle, and I was one of those people. The first one of those I’ve done, I’ve now done zillions of them, but that was the first one I did or was involved with.

An incredibly interesting group of people—one of them was a guy named, if I remember right, [Howard E.] McCurdy, who had come to NASA and had been Chairman and CEO of Sun



Oil. Another guy who had worked very closely with [James E.] Webb when Apollo was being formed, Jim [James A.] Abrahamson, who, at that time, was head of the F-16 program, but then became head of Human Space Flight at NASA Headquarters. Who else? A couple of other people.

I really say that because the reviews were interesting, but the dinners where we were just chatting about—the guy who had been with Webb was telling all kinds of stories about dealing with [President John F.] Kennedy and getting approval of Apollo, and it was like having a front-row seat to history. That was really quite an interesting experience. I don't know much else I can tell you about it, but we spent a lot of time going to JSC.

I remember we were interviewing Kraft, and I remember we went down to see Chris and all of his lieutenants and what have you were in the room. Chris said, "Why are you all here? Don't you all have something to do?" And he kicked all of them out and we sat and talked a bit. He had a very interesting view of it—which he always does; I'm a big fan of Chris Kraft—his view was, "God, there was something bad happened in Washington, a lot of my friends were probably injured, but sure glad it had nothing to do with us down here."

The Ames experience was short, interesting, probably my first real introduction to Center management, even though I'd been at a Center. When you're on a project, you don't care about anything else that's going on at the Center. I'll stop there.

WRIGHT: I was going to see if you wanted to talk any more about the Shuttle assessment because when we were looking into it, I think one of the aspects that the group talked about was it seemed to be an inadequate long-range planning effort that the team felt that needed to be put

into more. I was curious to see if there was anything from that study that you thought about or have thought about over the years?

YOUNG: Actually, the answer's yes, and I've come across it a bit. First of all, I'm not sure it's a good way to do it, but the way it was done was interesting in that—I guess Lovelace really said this. He said he was not interested in a consolidated committee view. He really wanted each individual to document their views, which was interesting because that's a way to do it. The circumstance was the following: the Shuttle was rolling along—and this is my perspective—the Shuttle was proceeding along. Basically the process was that they put together a request for a budget every year, and it's still the process, obviously. They advocated it, they got out of it as much money as they could, but not enough, each year. What they really did was they did all the work in the year that the budget would afford, and did it well. What they didn't have money for, they moved it to the next year. That was basically the process that was being followed, and they had no alternative. You could say that they were at the mercy of budget decisions that were made in Washington, and I don't know the details on all those.

What was happening was they were using schedule as reserve, in effect, so as I said, they did everything they could do for the funds that were available in the year; they probably did the top-priority items and probably did it all very, very well. But, they didn't accomplish the plan because there wasn't enough budget to accomplish the plan, so it moved forward. What happened was that that was a process. I think everybody was functioning in that regard, and then there was a DoD payload that had to be launched at a particular time period. That was when they were launching defense payloads. It had to be launched at a particular time period, and it was one the President was involved with. It was a program of that level of importance.

When they said it had to be launched—and Shuttle had never flown, obviously, they were still developing—at a particular time period. Then it became apparent, and I think everybody working on it knew it, there had been a deficit accumulated over time because every year, you weren't accomplishing the work that you had planned to accomplish. Even though, I really want to highlight, probably accomplishing everything that could be done for the funds.

There was an amount of work to meet that schedule, about \$5 billion that was un-funded. There was a bubble, or whatever you want to call it, that existed to do that. In order to launch when it was needed to be launched, there was essentially a \$5 billion budget problem. That is caused by, as I said, the total system failing to fund to the level, to the most probably cost of the mission, which I've actually, in my later life, seen a lot of programs like this. It's a tragic problem because the problem is when you do the work when it should be done, it maybe costs you a dollar. When you do it out of sequence like this, that same thing probably costs you \$3. It's a very expensive process to move, to delay things.

I think it probably happens throughout the government. What really happened in this case was, and the reason this review was taking place, all of a sudden, Shuttle had a \$5 billion problem, which was a big problem at that time. I think the JSC leadership probably said, "Why is anybody surprised?" I don't know whether you've had other people discussing this or not in your interviews, but they said, "This is the way the project has been managed." By the way, [International] Space Station was managed exactly the same way, and we may come to it.

That was the first real review that I'd been involved with, and it was the first time that I had really appreciated how much schedule was used as reserve. By the way, it's worth, again, commenting a little bit. Of the options [available], that was good. You'll say, "Well, that's a little bit crazy." The other option that could have been used would have been risk could have

been the reserve, and there are examples of that. We probably will talk about that. If the people at Johnson had not been so good and had been trying to prove that we can manage this thing for this budget no matter what, they might have taken the course where instead of schedule being the reserve, risk would have been the reserve.

When you use risk as the reserve, you're really in troubled waters because pretty soon, you're to the point of having failures. When you've got a given amount of work to accomplish and you don't have the budget to accomplish it, you've got to have some safety valve. The safety valve that was used in this instance was keep moving the first launch out, keep using schedule as a reserve, and when we get there, we'll do it. That was pretty good until somebody said, "You've got to launch on this date." That's when the problem really presented itself.

WRIGHT: Interesting. An interesting way for you to move into Goddard, and you have this little break of the study group, and then take on your own Center, and again for a short amount of time. Of course, you didn't walk into that—what were your expectations when you were asked to take the leadership at Goddard?

YOUNG: If, as I said, for somebody with my background, if you were identifying great opportunities, Goddard would be one of those. I was getting excited about the opportunity. Again, that was probably the last time ever, a little on the young side for it. I also remember Al Lovelace saying, "I'll tell you, a lot of my people say that you're not seasoned enough for this job, but I don't know what that means." He said, "Should I sprinkle salt and pepper on you?" I still remember that humorous discussion.

The Goddard thing, for me, worked out well. Goddard had—every Center has this—its share of extraordinarily competent characters. One of the things, and I want to say this right, also, I had one advantage and Bob [Robert S.] Cooper, who was a friend and really a very capable person, Bob and Goddard didn't get along well. That made my transition easier, in that regard. Goddard had always had a concept of being both a doing and a managing organization, and they had always had an in-house project as well as managing contracted projects. Bob stopped that, said there would be no more in-house projects, and I happened to have come to through the school that I thought the in-house projects were good things to do. It was a no-brainer that when I said we were going to do an in-house project, that love was just showered on me.

WRIGHT: Just a hero.

YOUNG: That was not a hard thing to do. I do remember a few items that jumped out, two or three experiences. As I said, first of all, really capable people. I guess that I had been involved in a lot of project activity, so I had a lot of experience with that, which was important to the Goddard mission. I don't know what I want to say, but I was a strong believer in identifying problems, solving them, and they fell in line with it. I think we got along well, so I can't say I really had any great problems at Goddard.

I remember again, something that goes back to this Viking experience we were talking about earlier, about no investigative reporters. I remember my first big presentation to the all-hands briefing, and by luck, I said, "I'm establishing ground rules for these briefings. I'm going to answer you in three ways for questions. One is 'I know, and I'll tell you.' The second is, 'I

don't know.' But the third is, 'I know, but I can't tell you.'" I said, "You're going to have to respect that." I said, "I'm not going to tell you that I don't know when I know, but there are some budget issues that are privileged." We had a rule in the beginning that things were in those three categories. That was a little luck, but not a terrible amount of luck.

A little bit was really based on, as I've said, what I had learned from others as I was coming along. That served me pretty well. I remember one other experience there. Almost day one, there was a collection of problems, but there was this big issue of a data processing a problem that Goddard could never get right. Headquarters and others, it was a big reputational item. We started getting together to work it, had Saturday meetings and Sunday meetings and the typical NASA approach. In a couple of months, we got the problem solved. So I went to one of the senior old-timers there and I said, "Look, I have a curiosity question—how did we solve that problem?" I said, "That had gone on for months and almost years, how did we solve it?"

Again, I don't want to get carried away with it, but it's an interesting thing. They said, "Look, if the Center Director decides this is the most important problem at the location, then the most capable people go to focus on it, and then they solve the problem." I learned a fair amount out of that process, and I think that's true. I think that's true no matter where you are. I think it's probably true in the White House, it's true at Martin Marietta. If the senior person says, "This is a critical problem that must be solved," the best people are going to gravitate towards helping solve it, and it's probably going to get solved.

WRIGHT: That is interesting. Do you feel like you set some things in progress and was able to make an impact in your short amount of time at Goddard before you left?

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YOUNG: Yes, I do, actually. We had some programs that were in serious trouble, Landsat being one I remember. Again, from the learning experience standpoint, there's a guy there named John [H.] Boeckel. John was head of Engineering at the time, but he really was looked at as the best technical person at Goddard. I remember on Landsat, we were having meetings all the time, trying to solve the Landsat problems. I remember John saying, "If you function tomorrow the same way you function today, you probably should expect about the same result." He said, "If we're going to solve the trouble, we've got to do something different."

They were just good people at Goddard, and I think the thing that I probably brought—and I don't want to get carried away with this—was that I identified very much with the kind of work they were trying to do. I really was quite supportive of what they were doing, and I think that we went about correcting a lot of the project kinds of problems that existed. It was one of my personal better experiences. My best experience, there's nothing that beats being a project manager. I knew when I finished Viking that I would never do anything like that again in my life.

WRIGHT: Never have that same feeling.

YOUNG: Yes, never have that same feeling. I remember, I'm really deviating, John Naugle, one time, he was now the number three guy at NASA, whatever he was called at the time, and John said, "You have had the opportunity to have the thrill of being on the project, and the rest of your life, your job is to create that opportunity for other people."

WRIGHT: That's a good legacy to leave, yes.

YOUNG: It is, yes, it is.

WRIGHT: Where we are is basically closing up your years at NASA, and those 21 years you were there were pretty full.

YOUNG: They were. They were terrific, and I figured I'd probably be there the rest of my life, and made a career change, obviously. People have often asked why, and I don't know if I even know why. I've always been an advocate and still am of the partnership between NASA and the industrial partners in making these things happen. I had a great curiosity as to how it really worked on the other side, even though I had worked heavily with the contractors and knew some of the people at Martin Marietta, I was not out looking for a job. They asked me if I was interested, and one thing led to another, and I made the change.

I will tell you that later on, when I went to Orlando [Florida] operations and the guy at Martin Marietta, the newspaper guy there was interviewing me about it and I was talking about this kind of higher calling. He says, "Oh, come on, it was the money, wasn't it?" But it intrigued me, how the process works on both sides. I just decided, much like when I went to work on Lunar Orbiter, to give the industrial side a try. It was a good decision for me, also. NASA was a terrific decision and that was a good decision. Now, sometimes there are Ys in the road and you don't know what the other branch would have done. I made the decision to go to Martin Marietta, left Goddard, which was a hard thing for me to do.



WRIGHT: This time, when you left a location, you also left the agency. You weren't just moving from another position.

YOUNG: That's right, yes. In retrospect, it was an different aspect of my career. I went to work there, started out working at the corporate headquarters. At that time, Martin Marietta had a position they called Vice-President of Technical Operations. It's not really a vice-president; I guess it's a title but it's not a corporate item. It was a position that they used at the time, used after that, too, but in essence, somebody like me could come in from the outside, and could pretty much see across the total corporation. The total corporation could pretty much see the individual, and you couldn't do much damage in the process. The guy who had the job before me was Norm Augustine, I don't know if you know Norm. Norm had it before I did, then I had it. In fact, I went there first working for Norm, then he went to Denver [Colorado], and then I took the job. It was interesting, got to see quite a bit of what happens on the corporate side.

I've often been asked, particularly by colleagues, about the transition. For me, the transition from NASA or from government or whatever you want to call it to the private sector turned out to be incredibly easy. The reason being that NASA's an organization, but all the things I was involved in were very objective-oriented or goal-oriented. Where industry, probably the ultimate common denominator is profit, it's a very goal or objective-oriented organization. Not that different than everything I'd done in NASA. I found the transition to be incredibly easy, in that regard.

The activity at the headquarters, a little bit like NASA Headquarters, it's not as exciting as being in the field operations. Somebody has to do it, so I don't mean to imply that, but so, I went from everything being a buzz to a different kind of an environment. Took me a little while

to adjust mentally to that, but that was more me. I actually was at headquarters for, I think, six months, and at that time, Martin Marietta was not an enormous company. They had really three primary locations, Denver, Orlando, were the two largest, and then Baltimore [Maryland], which was by far the smallest. Baltimore was largely a manufacturing activity. Norm had gone to Denver, so they had a super person in Denver, they had a good person in Orlando, and they had terrible problems in Baltimore. I was asked if I wanted to go to Baltimore. I came from a technology, high-tech, project kind of a background, and Baltimore was a blue-collar manufacturing kind of an operation, but I said, "Sure, what the heck?" It was interesting, too. First off, Baltimore is where the company began.

WRIGHT: You didn't have to move, right?

YOUNG: Didn't have to move, that's right. I went to Baltimore and learned a lot about the finance side of the business, which they had been terrible at. Learned a lot about dealing with a CFO [Chief Financial Officer] and that side of the business. I would say that my problem-solving skills, which were really honed from working on projects where that's all you're doing, is problem-solving, really worked pretty well there. Drove the people crazy, I would say, I think really crazy. We applied much the same concept of, all right, let's get it all on the table and see if we can't shuffle through this to find the problems and work nights and weekends. Actually, the organization—it's still a small organization—turned around pretty well, so that was good.

It had a mixture; it had commercial programs, it also had a major Navy project, which was called Vertical Launch System. This was a system that actually a guy in Orlando had created, where on Navy destroyers and cruisers you can launch missiles right out of the bowels

of the ship. I think you can launch one every second, and it can launch 120-some missiles, Tomahawks or different cruise missiles, one second apart. Just as fast as you want to. It's where almost all the cruise missiles that were used in Iraq and Afghanistan were launched, off of this. We had that system—I'm really coming around to it—the customer, it was the Aegis [Combat] System, and there was a Navy guy named Wayne [E.] Meyer.

I don't know if you've ever heard of Wayne Meyer; Wayne Meyer was the Admiral in charge of this program, and Wayne Meyer was just an incredible systems guy. It's a learning experience from the customer. Wayne, every morning outside of his office, had one of these flip charts and he had a pull up your socks list that he did every morning. He was so enormously dedicated to the success of this program. Again, even in a manufacturing, blue-collar thing, you interact with people who are just incredible.

Another guy who was there at Baltimore, a guy named Mel Ruth [phonetic], who's still living, who had been there for years. When Mel Ruth [phonetic] started there, he made \$0.37 an hour, I still remember that, because I remember he said the boss came out one day—and this has nothing to do with it, but it's just interesting—and said, "Mel, you're doing a terrific job and we're going to raise your salary. We're going to raise it to \$0.38 an hour on one condition, you don't tell anybody, because we don't want the word to get around that you're making \$0.38 an hour."

Mel Ruth, we had a program for the B-1 bomber, where we built the tail structure for the B-1. There were a lot of problems with it also, and it was probably one of the beginnings that Mel really was doing this. But, the basic concept in a lot of the manufacturing at the time was so-called commodity shop. You just take everything, the manufacturing people do everything, you just take your end and they'll manufacture it. He changed that around to being very project-

dedicated. Today, that's the technique that's used throughout American industry, really. He wasn't the father of that, but he was just the guy that was smart enough to recognize. Today, lead manufacturing and stuff like that all came out of that.

I was at Baltimore for I've forgotten how long, a couple of years or something like that. Then, I got asked if I wanted to go to Orlando—I don't know whether you're asked or not—but I went to Orlando. Orlando was a lot like Goddard in that it had a lot of high-technology activities. I left Baltimore, having had a terrific learning experience in the so-called manufacturing side, the industrial side of the business. It helped transition me away from just projects and NASA Center kinds of activities, and we went to Orlando.

Orlando was full of high-technology, pushing the state-of-the-art projects. We're doing incredibly good things, but we're doing it by what I used to quasi-jokingly and seriously say, "hand-to-hand combat," and that is that a customer wasn't happy, and it was just an agonizing way to do things. It was, again, a great opportunity to go there and try to make a real contribution.

They were delivering—now, some of these are small things, I guess the smallest was, like, Hellfire, that's the missile that the controversial drones fire—a missile or an electronic system every 10 minutes. It averaged out every 10 minutes on the working day, one was being delivered. We had about 17,000 people, and the volume of work was just incredible. Everything worked pretty well but was behind schedule, over budget, so that was what I encountered when I went to Orlando, which was a different situation. Interestingly, we used to joke, Norm Augustine, who came from an Army kind of a background, he went to Denver, which was all space, and I, from a space background, went to Orlando, which was all Army and Air Force

kinds of activities. I don't know what you want to know about those. I'll stop there. I'm away from NASA, so you probably want history of NASA.

WRIGHT: I think it was interesting, that you've talked so much about leadership. My curiosity now is going to lead you to talk to us about the types of leadership skills, and you've been bringing those in as you've gone through your work with NASA. Now you're out working with a company that does work in space exploration, and then as you lead up furthermore into your career, you start taking those two areas and you come back and try to be an independent voice. So much of these last 15 to 20 years, you have been able to work—I guess even on both sides—and lending your expertise or lending your problem-solving skills and doing that. If you could share with us some of those management pieces and some of those skills, and then maybe even reasons why you think that you were pulled into some of those studies or to lead some of those panels to come up with some solutions to some big problems?

YOUNG: That's a good observation, so let me touch on the Orlando situation. As I said, Orlando was an enormous amount of business, enormous volume of products, very important to the country. One of the programs was Pershing II, which really played a key role, clearly, in the SALT [Strategic Arms Limitation Talks] agreements and probably in the demise of the Soviet Union. It was one of the factors in it. Very critically important programs—night vision systems for both helicopters and for fixed-wing airplanes. Up until that time, the air was really a daytime operation and we really developed systems that turned it into a 24-hour operation, whether that's good or bad, we did.

As I said, the big item was the success for hand-to-hand combat, so again, a little bit of it was a problem-solving concept I had learned and had honed through the NASA activities. We went about trying to fix this. Again, a lot of good people, and so the first thing we did, I remember we had a big campaign and it was heavily-focused on quality, and we said, “Quality is one of the three legs of the stool. There’s cost, there’s schedule, and there’s quality,” a big poster, “and now that we understand that, we’re going to really go put a lot of attention on it.” Nothing happened. People didn’t have any idea what we were saying. “The three legs of the stool, you got to juggle the schedule and you got to juggle goals, the profit, you got to juggle the quality, and we don’t know what you’re talking about.”

We then got together and we said, “Okay, we’re going to have a new approach. We’re going to say that quality is first amongst equals. We’ve got schedule and cost, but quality’s more important than either one of those, so it’s first amongst equals.” We had a big effort on that and nothing happened. Nobody understood what we were talking about. We finally got together—you really touched on this, I think this comes from NASA and really space—and I said, “Okay, we’re going to try a new approach.” I will tell you, I was petrified at this. I said, “We’re going to say that quality, meaning doing it right the first time, is it. Nothing else matters. If we never make another penny, if we never deliver another product, we’re going to do it right.” The space world is mission success-oriented. We said, “That’s it, quality is the only thing that’s important, and if you’re building something and the drawings are not right, stop. If the test is not going right, stop.” We kind of put that out as a concept and as I said, I was petrified the whole place would come to a screeching halt.

There was a person on an assembly line on what was called TADS/PNVS [Target Acquisition Designation Sight/Pilot Night Vision Sensor], which was the navigation and night-

targeting system Apache helicopter. Stopped the line, she said, “I can’t build it to this drawing.” I don’t think we realized it, but I think 15,000 people stopped with alarm to look as to whether or not we’d fire her. We told her to take the week off, or what. It was a slightly different time, but what we did—this was mid ’80s, now, at that time—we gave her a clock radio and we said, “Hey, what you have done is terrific.” It was the belief that for people doing the right thing, you don’t lavish them with a lot of stuff, but we would give somebody dinner for they and their significant other, so when people did what we were asking them to do, instead of shooting them, we rewarded them. The turnaround was incredible.

The other thing that we did—which is back to what, I think, I was talking way back in Viking—was the government was a big kick at the time. NASA started doing it somewhat, but mostly, it was the DoD organizations. They would come in and do audits. We said, “Well, why do we wait for them to come in? Let’s do our own.” We put together our own system of looking at ourselves and we had red-yellow-green reports, which is not very innovative. Every organization, every place, whether it was manufacturing optics or whatever it was, they had a red-yellow-green chart, and most of them were red, at the time.

We had a big visit coming by the customer, a big deal. There was a lot of debate that we should not have these boards up when the customer came through because it was kind of admitting to problems. Again, I think it goes back to the Viking investigative reporter, but I decided, “Hey, we’re going to leave them up. We’re going to do it exactly as it was.” Again, a turning point, that people said, “Hey, maybe these folks are a little bit serious about the whole thing.”

Then, the government became somewhat a partner and they said, “Okay, here’s the criteria you’ve got to have to so-call pass these future audits.” We got on the kick of saying,

“We don’t want to pass, we want to pass with excellence. Passing’s not good enough.” We began to build in these themes, and the first theme was quality. As I said, if you’re talking space, mission success, that’s the only thing that’s important. In the end, if you do that right, the rest will take care of itself. The second thing we said is transparent, don’t put the charts back just because the customer’s coming in. The third thing is, don’t just pass; pass with honors. That’s what we said, “Pass with honor.” An astonishing thing to me was most people said, “This is a multi-year project,” and in six months, we pretty much had solved the problem. What I really mean by that is not only we were delivering on time, but we were also within budgets, but the other side issue thing for everybody was that even though we thought the quality was really good before, everything was better. The products were better.

I do think—you really said this yourself—I think from my standpoint, a lot of that came from some of these experiences that I had at NASA. I think, again, the people, they were ready for this long before management was. They were saying, “Tell me, why are we screwing around with all these crazy things? Let’s just get on and do the right thing.” By the way, a lot of it, again, you see in some of the things that are happening in lead manufacturing and what have you, but we really institutionalized this. There were a lot of next-level managers who were just very taken. They were just waiting for somebody to tell them to go do it, so to speak, and we turned an organization around in a very short amount of time.

When I run into people from down there today, they’ll still comment on that experience. What I got out of it is it doesn’t matter what you’re doing—and you call it quality or call it mission success or what have you—if it’s number one, everything else will probably be better. If it’s not number one, you’re probably heading for a lot of trouble, which I’ve found a lot of places were heading for a lot of trouble in some of these crazy reviews.



Orlando was really a good experience in that regard. Then, after that, I went to our corporate headquarters for five years, I guess, as President and Chief Operating Officer. Norm was CEO and Chairman, so Norm and I had adjacent offices for five years, so we worked closely together for that time period.

WRIGHT: When do you remember starting to be kind of the go-to person to pull in groups together to make outside assessments? I know that in '97, you were asked to review the safety of the Russian Mir Space Station, to help decide whether that was a good time for Dave [David A.] Wolf to go up, but do you remember the other ones prior to that?

YOUNG: Let me kind of come back, that's a really good item. I don't exactly know, to be honest with you. I was on the NASA Advisory Council for a long time, when Dan [Daniel S.] Goldin was there. I'm sure you've gotten a lot of Dan Goldin stories over the time. I'm actually an admirer of Dan Goldin, and he too is an unusual person. Let me even back up a bit.

At corporate headquarters, while I was there for the five years, the whole industry changed. The Defense budget declined enormously. The procurement in the R&D [research and development] budget, which is almost where all contractors are funded, was reduced by more than half. Today, we talk about 10 percent and everybody panics. There was a real activity aimed on what to do about this. We were trying to figure out, at Martin Marietta, what to do. I don't know quite where I'm going to go with this, but it was an interesting experience. We knew the world was changing and we knew the budget was changing, and we knew that we had to do something different.

As a corporation, we always were very focused on strategic planning, but we did something slightly different. That is, we would take an afternoon and we would either go to Norm's house or my house or the CFO's house, and we would just leave for the afternoon. Most of the time, it was three of us, the CFO, Norm, and myself, and we'd go off and we would just talk about and argue about what was the right thing to do. We did that for probably a few months, and then we said, "Okay, maybe there are other people out there have some bright ideas." The people who really look at corporations are the Wall Street analysts, and there were a lot of them at the time. They were always coming by, "What are you going to do?" We said, "We're not going to pay you anything for this, but anybody who wants to, if you want to come in, we'll take a better part of the afternoon and listen to what you have to say. The fundamental question is, if you were running Martin Marietta, what would you do?" We did that.

We had maybe 20 people at different times come in, and some of them really were quite interesting. We did what I kind of crazily call strategic-strategic planning. When we finished that process—and this is how to deal with just a big change; NASA has the same big changes to face—we fundamentally got our convictions as to what we thought was the right thing to do. We concluded that the industry was going to consolidate, and you could either be a buyer or a seller, and we wanted to be a consolidator and not a liquidator.

We asked our board of directors, who was quite a good board, to come and spend a Saturday. We said, "Look, we want to tell you what we think we should do, but we don't really want to do a typical board of directors' thing." We didn't want them to have a vote, "we want you to argue with us, to test us." We said, "What we're about to do is going to forever change this company," so we did that.

When we finished, the management and the board were on the same page. I will tell you that we put together a list. We said we thought that companies that had defense or space parts of their business would get rid of them, and then later, major companies would consolidate. We put together a list, if we were king for a day, what we might have happen. Two weeks after that, Jack Welch called up and said, "I'm thinking about selling the General Electric aerospace defense business, and you're my choice to buy it. If you're interested, let's have dinner." Two weeks after that, the deal was done and the board approved it.

The reason was, it had all been thought out in advance, and the board was on board. We went through it and then, on a Saturday, I remember Norm came in and said, "Well, I just had an interesting call. Dan [Daniel] Tellep just called up and said, "Do you have any interest in putting Lockheed and Martin Marietta together as companies?" Fundamentally, Martin Marietta went from \$5 billion sales to \$35 billion, and they went from about 40,000 people to 180,000 people, out of that process. Interesting experience, in that it really came from just an awful lot of preparation and an awful lot of discipline.

Once that was done, the Lockheed one was done, it's not something I thought of before, but I thought, "I'm not sure that I wouldn't like to have a third life." I say that my first life was NASA and my second life was Martin Marietta. I didn't know what the third life was, to be honest. I was, relative to corporate retirements, relatively young. I was 57 at the time, and I remember talking to Norm, and I said, "Norm, I think I would like to retire, and I don't know quite what that means, but I would."

He said, "Look, why don't you take a month, and you and I will not mention this discussion again in a month, and you tell me whether that's still what you'd like to do." I did, and my interest was in doing some of the kinds of things I'd done, but I didn't know exactly

what they were. The answer was that I—not different than tons of other people—knew a lot of people, both at NASA and in the DoD world, and jokingly say, when you're free and available, you can get a lot of work. One thing I was not interested in doing, and I was fortunate enough that my corporate life had allowed me to do it, I wasn't interested in consulting. I didn't want to be a consultant. Two or three people asked me to do things; I said if I could help, I'd be glad to. Joe [Joseph P.] Allen was one; Joe asked me to come look at his company, and I said, "I'll do it only on one condition—you don't pay me."

About that time, two or three things came along. Mir was the first one. I was on the NASA Advisory Council, and knew Dan reasonably well, and Dan said, "I'd like to chat with you, I've got a real problem. There's a lot of concern about the risk of flying U.S. astronauts on the Russian Space Station." He said, "Would you be willing to take a look at it and tell me whether or not what we're doing is a good thing?"

I said, "Sure, I'd be delighted to. How long do I have?"

He said, "Well, the next launch is in two weeks."

I said, "Well, terrific, who's going to help me with this?"

He said, "You can do it by yourself or you can get somebody to help you. It's up to you, but I just need to know before we have the next launch whether we should do it."

I had three people that I asked to help with it. One was Larry [Laurence J.] Adams, who had been President and CEO, had the job that I'd had at Martin Marietta before me, one was Charlie [Charles F.] Bolden, and one was Frank [L.] Culbertson. The four of us met for a few times, and really a side issue, but one of the things I really learned is, first of all, Frank Culbertson, you got to know because you just talked to him, is just an incredibly capable guy. We went off and looked at it, and simultaneous with that, Tom [Thomas P.] Stafford headed—

and probably still does—a standing review with the Russians on doing the Russian joint stuff. His group was also looking at it, but we were an ad-hoc group.

We really concluded rather quickly that there are two ways you can really be killed on the Space Station. One is you can have a rapid depressurization, and one is you'd have a fire. They'd had both of them, Mir had, but the big issue that everybody was concerned about was that Mir is getting old, and was that the problem? The two ways you can get killed had nothing to do with age—it could have happened any time in the process.

Our conclusion was that it was no riskier—we said life up there may be terrible, with the temperature control bad and what have you—there was no additional risk of continuing to fly than there was when they first started in the process. That was really a controversial subject. When Dan was having a press conference for us, both Tom and me, to report, they snuck us in the back of NASA so we wouldn't see the press.

That was one that I did. I really touched on the Shuttle one because that really was the first one that I had done extensively. I think out of all of this process—and we'll touch on several of those because you probably have a list; I've done a lot of them. I think again, because of my background, the kinds of things that I had been exposed to and the kind of people I've had as mentors over various parts of my life, largely from the NASA activity, but then carried it over to corporate life, I developed a problem-solving capability. Most reviews don't ever get to the root cause. Most reviews get to the cause, but not the root cause.

I think I learned enough over time that if you don't understand the root cause, you're probably not going to solve the problem. I'm a stickler for really trying to understand root cause. As I said, on this, it wasn't a great invention, thought, but on the Mir thing, it was that there were two ways to be killed, and if you've done everything you can to minimize those, and if you're

going to be in this business, it's a reasonable risk to take with it. I think one of the things—I'm always hesitant to say what I want to say—I probably have a real capability at is not being satisfied until you get to a root cause of the problem, again, having a way to dig to find that. Often, people who have been reviewed probably don't enjoy it a whole lot in the process. I did that one, and then it wasn't long after that that the Mars '98 failure occurred.

WRIGHT: A couple of years later, he asked you to do that one, and you found the root cause of that problem.

YOUNG: Dan called me at home, I remember, and I still remember this experience. I was sitting with my wife, and we were watching TV and Dan was on the phone. Dan was talking about patriotism and do good things for your country and my wife was saying, "Tell him no, tell him no."

I said, "Dan, any chance we could discuss this tomorrow?" I took that, I chaired it. There are just a lot of good people who are around. I guess the other critical item of these reviews is they really be independent; it's so important they be independent. There was a little concern that Martin Marietta was the contractor, or Lockheed Martin, at the time, and so I told Dan, I said, "You need to think about that."

He said, "I have thought about it." In fact, even when I testified, I got asked about that question. I think you often go in with preconceived notions, but the other thing that's important is to really be pretty open, and that your preconceived notions are typically wrong.

I went into that one and really with a pretty intense effort. The interesting item was a little bit different than Shuttle, I talked about earlier, this was when faster, better, cheaper was

happening. Nothing wrong with faster, better, cheaper, except that the way people were implementing it. The whole problem with the Mars '98 was they didn't have enough money to do the job, and a planetary program makes it harder because it's a fixed launch window. Fundamentally, a competent but inexperienced project manager really used risk as the reserve and risk is a little bit like radiation. It comes in small doses, but it accumulates until it kills you.

Mars '98, I would say, had no chance to succeed. Most of these things, probably even bad programs, are only a 20 percent chance they're going to fail. Mars '98 probably had a 90 percent chance it was going to fail. If it hadn't been the reason that we identified, it would have been something else, and it fundamentally was using risk as a reserve. I think out of that, again, a little bit of a rewarding situation. I think it's forever changed NASA, the review of that program, as to how they treat programs and look at programs.

These things bounced along. When that one was over, Pete [Peter B.] Teets, who was President and Chief Operating Officer of Lockheed Martin, and they started having some Titan failures. Every time you'd launch a Titan with a classified payload on top, it's about a \$1 billion package, and they were having failures. They were concerned about it, and Pete asked if I would chair for Lockheed Martin an independent review of their activity. Again, had really super people, and we did it. It was a little bit back to, again, what we were talking about. In essence, what had happened was cost had become more important than mission success, and, by the way, stimulated by the customer, the Air Force. Really, if mission success is not first, you have a big problem.

A real example was one of the Titan IVs with a classified payload on top. Martin Marietta, and then Lockheed Martin, always had at the Cape a handful of people, gray beards, who always, jokingly said, didn't have a job. In other words, they're kind of like firemen—

firemen don't have a job, but they have a responsibility, and these people are the same way. Their job was just to be a third set of eyes, or whatever you want to call it, to help assure success. In this enthusiasm by the Air Force and by the corporation to reduce costs, they got rid of that group of people. On this particular program, in the guidance equation for the Titan IV, somebody wrote down a gain or a multiplier to guide this equation, and it should have been  $10^0$ , and it was  $10^1$ , handwritten, you could see it on a piece of paper, just wrote it down.

An important thing to recognize in all of this activity is that we're involved in a business that's very unforgiving—space—but it's executed by humans, and humans make mistakes. It doesn't matter how hard you try to minimize, there are going to be mistakes. You shouldn't assume that you can ever make it mistake-free. You can't. What you have to do is to have a process that keeps that human mistake from being mission catastrophic. We do that by testing, we do it by independent analysis, we do it by independent reviews, there's various ways that we have a safety net to make sure it doesn't happen.

This group at the Cape was one of those pieces of the safety net. This got written down wrong, got implemented in the software, got missed in the test program, and the vehicle was at the Cape. They were going through checkout at the Cape, and there was a group of people there that check it out who are knowledgeable but not expert in the systems. This person noticed that in the roll channel, it looked different than it typically looked.

The normal process would have been to have gone to these five people I talked about who don't have a job and say, "Hey, would you take a look at this?" They would have solved the problem, no question. Those people weren't there, so this individual sent an e-mail to somebody in Denver, who happened to be on vacation, in the process. The net result was it was launched with a problem there, and it was a \$1.2 billion failure.



These things are small problems, and so, again, back to what I was talking about, you could say the cause was clear, but the root cause wasn't. The root cause was that the basic corporation and the Air Force partner had moved to the point that cost was more important than the mission success. By the way, I don't think they would say that—I said it wrong, too—it wasn't that it was more important, it was just that it was the top priority. People recognized that. It's a little bit back to this Goddard experience I was talking about, how in the world did we ever solve that problem? If every time you go in the meeting, the first thing you're asked about is cost, you probably don't believe mission success is the top priority.

Did that one, and then another one I did was for Pete Teets, again. He had gone to be an Undersecretary of the Air Force, head of the NRO [National Reconnaissance Office], and they had big problems. Pete asked if we'd come in and do a review for them, and did that. I guess it was before, I don't know, somewhere along there, I did the Space Station cost and management review.

WRIGHT: That one's pretty significant, in the fact of was there a question of stopping construction on the Station at the time.

YOUNG: Yes, it was.

WRIGHT: Then, the transition of Administrators at the end of that report.

YOUNG: That was. In fact, a humorous side to that—which is public, I guess—was testifying on the report. [Sean] O'Keefe had been at OMB [Office of Management and Budget], when it got

started, and so he was testifying for the administration and I was giving our results. The chairman was [Ralph] Hall, from your State of Texas, so we'd been all morning, it went on, and on, and on. Hall said to O'Keefe, "Mr. O'Keefe," or "Honorable O'Keefe," or whatever, in a little sarcastic way, he said, "Your staff has told me that you must leave here by noon as you have another commitment, so I only have one more question I'd like to ask you before you go."

Sean, to his credit, recognized that a faux-pas has taken place then because Hall was really angry that he decided he had to be somewhere else. O'Keefe said, "Mr. Hall, nothing's more important than being at your committee. I'll stay here as long as you want, so I will cancel whatever else I had to do today."

Hall said, "Well, frankly, Mr. O'Keefe, I'd prefer you left after this question."

But you're right, it was. That was dealing heavily with the human space flight activity, and we spent a lot of time at Johnson and the various Centers. I guess one of the items that came out that I think people really worked on, Johnson had become—which is, again, a really good lesson—a pretty insular organization. They had the attitude, with a lot of justification, that at that time, only two people in the world over know how to do human space flight, the Russians and us; that we're better than anybody else.

You can understand how you could do that, but once you develop that attitude, you cut yourself off from a lot of learning because there are a lot of people who know how to do things. If you lose the motivation to listen, to interact with other people, to recognize that maybe somebody else has some good ideas, pretty soon, you're not as good as you used to be. I think Johnson really had slipped into that kind of characteristic. That was an interesting one, and, well, they're still going on, still doing one for NOAA [National Oceanic and Atmospheric Administration], for the meteorological satellite programs.

WRIGHT: Yes, I was going to ask you about that one because I remember being at the Earth System Science at 20 meeting several years ago. They had a map of the world on the wall, and then watching all the lights go dark of the satellites that were going to go away within the next 5 to 10 years. You're kind of in the midst of this discussion as well, of trying to find the way to decrease the gap of those satellites?

YOUNG: NPOESS [National Polar-orbiting Operational Satellite Systems], which was the joint program between the Air Force and NOAA and NASA, was proceeding along, and had a fair amount of trouble. I was asked to chair a review of it, again, with some extraordinary people involved. Our summary statement was that there was a negligible probability of success on the program. I guess this was arrogance, that's probably not the way to say it, but it said that the probability of success was actually zero, but you need to leave room for a miracle.

If you go back, again, a lot of what happens to these programs is unintended consequences. Nobody starts out wanting one of these things to fail or not go well. Way back when [Albert A. "Al"] Gore [Jr.] was Vice-President, there was a major initiative in reinventing government and saving money, and one of the items was there were two meteorological satellite programs. The Air Force had one, called DMSP [Defense Meteorological Satellite Program], and NOAA had one, which NASA was a partner with, and the idea was if you put those two together, you could really save a bunch of money.

The problem was that people didn't recognize that in crunch time, their objectives were different. NOAA's objectives actually were more demanding over the Air Force's objectives, and the Air Force had the control of the contract and the budget. Congress had directed that they

each be a 50 percent participant, and the Air Force wasn't going to put any more money in, and NOAA couldn't accomplish their objectives unless more money was put in, and it was guaranteed to fail. They couldn't come to accommodation, and the only solution was that the White House had to cancel the program and direct they go in different directions.

It took so much time that the probability today is very high that we will have gaps in the coverage of the meteorological data. I don't mean you can't put it there, but it's off the subject. An interesting circumstance with [Hurricane] Sandy, the best model actually that forecasted Sandy was a European model. There are tons of these models, but the European model actually forecast the strange left-hand turn that Sandy took earlier than the other models. All of them eventually did it.

If you take the satellite data out of the models, the forecast is it would have gone out to sea. If there had been no satellite data, there would have been no warning for New Jersey or New York with it. Really, a serious item that people were not paying much attention to because of mixed signals. The program does both meteorology and climate, and climate is a very political item, and a lot of signals were coming from higher-ups that climate was more important than gap. Therefore, project people said, "If that's what people are saying, then I'm not going to worry about the gap." Our push, which has now been done, is take the climate stuff off. Make it meteorology only, which has been done. It's a contribution that review groups can do—I mean, review groups typically tell people to do what they know they should be doing anyway.

WRIGHT: They have somebody else to blame, right?

YOUNG: Yes, that kind of highlights it. We're about to go back and do a reexamination because it had a whole lot of aspects to it. NOAA's management had really deteriorated, and Senator [Barbara] Mikulski was going to move everything from NOAA to NASA, and probably not the right thing to do. They're still on probation. We're going to go back and do a re-review in August of it.

WRIGHT: Keeps you busy?

YOUNG: There's a bunch of activities, so that's kind of been my third life. My third life is doing these. I think again, you really helped me understand it, but my background with NASA—and a lot of other people—really has facilitated us being able to do credible reviews, and critically important that they be independent. I go back, and I'll say something again about NASA in that regard, really for Dan Goldin. A lot of people characterize Dan differently. In the reviews I did, Dan never once made a suggestion as to the outcome. Never changed any aspects of their findings. Never changed any aspects of the report. He, too, was adamant that they be independent and not have his fingerprints on it at all, which is exactly right. I went on Mars '98 and briefed the White House on it, and he didn't go. I testified, and nobody from NASA reviewed my testimony before I went.

I never had anybody really try to influence the outcome of the review. I've had people on projects who thought what we were doing is dumb or crazy, and one person I much admire, Tommy [W.] Holloway, you know who I'm talking about, I remember one time we were having a heated discussion. He said, "We're the only people who really know about human space flight, you can kill people in this, and what do you all know about that?"

My comments, I said, “Tommy, you know more about human space flight than I do, but we do know a little bit about management, so we might learn from you and you might learn from us in this process.” There’s been a lot of pushing back and what have you with it, but overall, I think the reviews have gone well, and generally they’ve been welcomed. It’s something I kind of have found rewarding in my so-called third life.

WRIGHT: Let me ask you one more, then I’ll certainly let you go because I don’t want to wear you out before you head back. In fact, it’s just recent that you’ve testified, and has to be what you believe, that maybe NASA and the civil space program is on a declining trajectory, I believe, was the term that was used coming out of those. Based on everything you’ve told us about all these experiences over the last years, can you give us your thoughts on those and what you would recommend on how to turn this trajectory around?

YOUNG: Yes, I’ve testified several times on this subject, but I recently did it, and did have some thoughts, there. Human space flight is probably the largest concern, and we do not, in my view, have a credible human space flight strategy. I’m going to touch on it in a little bit, and then I’ll expand a bit beyond that. We went through this for quite a bit, what do we do after Shuttle? Constellation came out as the option, and then this administration cancelled Constellation.

There’s no question that there’s a collection of people, influential in the direction of the space program, who are very focused on NASA facilitating the commercial end of it. My personal beliefs are that the commercial cargo is a reasonable thing to do. I personally am adamantly against the commercial crew. My reasoning is a collection of it; I believe that the country benefits enormously by having a highly-capable NASA and a highly-capable industry,

where NASA is setting direction, NASA is a continuity of expertise as to how to do these things, and industry is extraordinarily capable implementers. I think that partnership is so important, and I think that whatever we do, we should preserve it.

For the commercial activity, I think anything that people want to do, like the Virgin Galactic activity, I'm all for it. If people want to pay for joyriding in space and it's a business, terrific. I just don't want to compromise the NASA capability in order to facilitate the commercial side of it. I think we're doing that; it's my personal belief. I think that the Space Station—and I also had this in the testimony—is an incredible technological achievement, a marvel, a real success in terms of diplomatic activities. I'll use almost the words I used in that testimony. It's on the cusp of being a scientific and research failure. What I really mean by that is we spend almost a fourth of the NASA budget on Space Station, and we spend more on Space Station than we do on all of the planetary, astronomy, solar system exploration work, and I don't think we get the return for it. I'm not convinced that we're spending the money on the highest priority. I'm back to where I was way back when you maximize the budget and then do the highest priority kinds of items. I recognize these are not easy items, but I think we're muddling along, is my personal view.

Do you blame anybody? That's hard to say. Everybody has a role in this. There's no question about this administration has a focus on the commercial activity, and I recognize that. I just don't put commercial crew as more important than maintaining the expertise of NASA. When I look around, I think it really is somewhat on a decline, and to me, it's a real worry. Maybe everybody, when they're in their third career, worries about things like this. I don't know. I don't see a great activity aimed towards, "My God, we got a problem, and let's see if we can't fix it."

I don't know what you see—you see a lot of this from the things that you all are doing. I don't think it has to be the old NASA. The asteroid mission, my original thoughts with that, and I'll acknowledge, was, that actually makes a lot of sense. No gravity, easier thing to do. Turns out, an asteroid mission is a hard mission. I'm not talking about this lassoing one, but, there are not a lot of targets, they're small, most of them are tumbling, the trip times are in excess of a year, the risk is high, and you don't really walk on one of these things. If you do rendezvous, it's almost like scuba-diving. You get out, it's almost like an EVA [extravehicular activity] up to it. I think that the more we've learned about it, the asteroid makes no sense whatsoever as the target.

We've got this mentality, and I don't mean this to be political, but “The President said we're going to do it, so therefore we're going to do it.” If it's wrong, somebody should tell the President it's wrong, this is not the right thing to do. I happen to think that this go out and put a net around one and bring it back, is not exploration. I just think that we're not sitting down and facing up to issues and deciding what we can afford and what we can't afford. Budget is an issue, I recognize that, but I also believe that great nations do great things. We should decide, is it important? I think what we're doing is that we're muddling through, and we should be a lot better than that.

WRIGHT: Was there anything else? I know we could talk for more hours, but is there anything else you can think of, off the top?

YOUNG: I don't know, I don't know whether any of this is useful to you.



WRIGHT: It's all great. I guess one of the other projects you're working on, it's interesting—it's not corporate and it's not a federal institution—you're working on a kind of collaboration between the Commonwealth of Virginia and with the Mid-Atlantic Regional Spaceport [MARS]. I understand you're on that board as well?

YOUNG: That's an interesting experience—interesting and frustrating, also. I live about 20 miles south of Wallops, care a lot about NASA, and Wallops has been an orphan and is really one of the growing aspects of it. Before me, there had been a concept of having a Wallops research park, which I thought was a pretty good concept. All of the state and local stuff to make it happen all happened before my time, but there is a committee chair, and I chair the Wallops research park. I had this idea that if you're really going to make this thing a success, it needs to be a partnership between the state and the local folks.

The idea is to build a park with infrastructure, but also, NASA has agreed that their facilities can be used, but you've got to build a taxiway to connect the park to the NASA runway. We were proceeding along the line of a partnership—again, talking about how the money changes, we're talking about a total of \$8 million, 4 for the county and 4 for the state. I thought the state was a done deal and the county was the hard item, so I spent a lot of time convincing the supervisors to do it, and actually got it to the point that it's a vote of 8-1 in favor. Now, the state is choosing not to support the \$4 million, so they spent a bunch of time on that. In fact, they're doing a letter to the governor, saying what a dumb thing this is that they're doing. I don't know, some of these things are just hard.

WRIGHT: Yes, then you have the challenge of a new governor coming in as well.

YOUNG: Yes, there will be a new one coming in. Then, they do have the MARS activity, as you said, and they put together a new board and I'm on that. I have a little background with that. It's interesting, when I was in Florida, the governor at that time—this was mid to late '80s—became interested in how space could be a larger part of the Florida economy, even though it was booming at that time. I chaired a review for the governor. My co-chair was Jeb [John Ellis] Bush, so Jeb Bush and I spent a year working together, doing it. We recommended, which is now the competitor, that Florida have a space port.

WRIGHT: It all comes back to haunt you, doesn't it?

YOUNG: Yes, and put it together, yes.

WRIGHT: Wallops became part of Goddard when you were there in that time brief time.

YOUNG: They did, that's right.

WRIGHT: It must just be in your stars, that's what happened.

YOUNG: That was interesting. There was a lot of pressure on NASA at the time, they had too many Centers, so they got rid of two Centers by making Wallops part of Goddard and [NASA] Dryden [Flight Research Center, Edwards, California] part of Ames. I don't know whether that did anything or not, but I know that the Director of Wallops didn't think that was a very good

idea. I've seen a lot in the process, and it's been an exciting time. It can be a great time in the future, if we're up to it. The country right now, in many ways, we're trying to find our way on some of this new stuff.

WRIGHT: No easy path, is there?

YOUNG: No, it isn't.

[End of Interview]