

NASA AT 50 ORAL HISTORY PROJECT

ORAL HISTORY TRANSCRIPT

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INTERVIEWED BY REBECCA WRIGHT
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The questions in this transcript were asked during an oral history session with Michael L. Coats. The transcript has been edited for a publication and does not exactly match the audio recording.

On January 16, 1978, NASA announced the members of its newest group of astronauts, the first class specifically selected to fly the space shuttle. Thirty-five names were on the list including Mike Coats who received the news on his birthday. As an astronaut, he flew on three shuttle missions, as pilot for the maiden flight of Discovery, and as commander on two subsequent shuttle missions. Before joining NASA, Coats was a distinguished U.S. Navy aviator, where he logged more than 5,000 hours of flight time in twenty-eight different types of aircraft. In August 1991 he retired from NASA and the Navy, and worked in the space industry for almost fifteen years. Coats returned to the space agency in 2005 to be the tenth director of the Johnson Space Center.

In an interview held January 4, 2008, he shared experiences from his first years with NASA and its burgeoning Space Shuttle Program. From the Center Director's Office in Houston, Coats explained how his current role is involved in the final days of the Orbiters, while at the same time he assists the nation's space program in its transition to the newest era of exploration, Constellation.

When NASA decided to pick another class of astronauts, it was to be the first class in about 12 years. I was fortunate to not only be at the right age at the right time, but be at the right place. In 1977, I was an instructor at the US Naval Test Pilot School [Patuxent River,

Maryland]. I was a military pilot, military test pilot. Almost all the pilot astronauts have been military test pilots, so they came around encouraging us to apply for this new class. This class was to be the first class of Space Shuttle astronauts, and with the first women and the first minorities.

I actually agonized about whether to apply or not. I really enjoyed what I was doing with the Navy, and my wife didn't want me to apply to be an astronaut. The night before the deadline, I went ahead and decided to apply to the Navy first. They have a selection process and then they forward the names to NASA for its selection process. Actually, I wasn't terribly interested in the astronaut program until I came down to Houston after being invited down to do a week of interviews and physicals in August of 1977. I fell in love with the place.

Chris Kraft, who was the Center Director at the time, told us, "The week leaves a lot of free time to go talk to people. I encourage you to go talk to not just the astronauts but the engineers and everybody here, and find out what they do and how they like their jobs here." I thought well, okay. I'm going to go find somebody that doesn't like his job. That was my goal that week. So I really spent every spare moment walking into people's offices around here introducing myself. A complete stranger, I asked, "What do you do, how do you like your job?" Everybody I talked to just loved what they were doing. That made a huge impression.

Remember, this was in 1977. It had been a year or two since we flew the last Apollo mission, Apollo-Soyuz [Test Project]. It was going to be three, four more years before we flew the first Shuttle mission. It was a downtime for people. Yet morale was just sky-high. Everybody I talked to from the taxi drivers to the janitors to the engineers to the astronauts, everybody really enjoyed what they were doing. So I thought wow, being an astronaut would

certainly be a cool thing to do, but working with a group of people that really enjoyed their jobs would be especially special. Then, I really wanted to be selected.

They were interviewing in groups of twenty, interviewed about 120, ended up picking thirty-five. I was really anxious to be selected. Because they went alphabetically, I was in the first group interviewed and had to wait about five months before we heard anything. I was in graduate school at the time. January 16th, my birthday, 1978, they made the announcement. I was fortunate to be selected as one of the 15 pilot astronauts. I got to start with the class in July of 1978.

It was really a special time for us, because this class had a real mixture for the first time. Most of the previous classes had either been pilot astronauts or scientist astronauts, including medical doctors. In our class, we had fifteen pilot astronauts, and we had six women, we had engineers, scientists, medical doctors—a real mixture of folks, and the age difference was pretty large too. It was fascinating to see the interaction of that class of 35 people, because nobody was really senior to anybody else, and we outnumbered all the astronauts that were already here. There were only 29 astronauts when we got here, and we were 35 more.

Suddenly we dominated, but they were glad to see us, because they had a lot of work they needed us to do. It was really fun for us because there were enough Apollo astronauts still left over that they were able to mentor us, and we really enjoyed that. Of course we were still developing the Space Shuttle and learning how the orbiter was going to operate. We got involved right away in developing operational procedures and flight rules for this amazing new vehicle; it was really a special time.

Now it was a lot of hard work for us back then, long hours. I immediately got assigned over to the Shuttle Avionics Integration Laboratory, which was running 24-hours-a-day, 7-days-

a-week, trying to test out the avionics and software. We were literally working continually, around the clock, and we thought it was important to do. It may have been a lot of fun, but it was a lot of hard work as well.

We were preparing for the first Shuttle mission, and I was personally fortunate to be asked to be the family escort for the first Shuttle mission. I escorted John Young's and Bob [Robert] Crippen's families during the activities for their Shuttle mission—both for launch and then during the mission, and for landing out at Edwards Air Force Base in California. This was precedent-setting if you will and I really enjoyed that. It was fun to be right in the middle of all the “firsts” that were going on.

Then soon after I got assigned to my first mission, which I flew as a pilot in 1984 on STS 41-D, the 12th Shuttle mission. Flew that, and then actually went in training for my first mission as a commander. We would have been up with the mission in the summer of 1986, but the *Challenger* accident happened [January 1986], that delayed everything for about two and a half years. So I ended up flying as a crew commander for STS-29 [March 1989] and again on a third mission, STS-39, in April 1991. Between my second and third missions I was the Acting Chief of the Astronaut Office for a little over a year. After my third mission, my wife said, that's it. Actually, she said that after my second mission.

I'll tell you a quick anecdote. She knew I had to go fly my first mission as a commander, because I'd been assigned, been through training and so forth. But she had insisted that after that one, that was it. The loss of *Challenger* was very difficult for her. Those were our classmates and friends, and we knew the families extremely well. In fact I was the one that they asked to go in and tell the families after the accident that there wasn't any possibility of search and rescue.

So she had made me promise that second flight would be my last flight. Then, we'd go do something else.

But it turned out that that mission was the first flight of President George H. W. Bush's administration. My wife came up with this crazy idea at the last minute. "Oh, we've got to get ourselves invited to the White House. Let's fly something for him, and he'll invite us to the White House." This was like a month before flight.

The Orbiter is on the pad, everything is stowed away, and this really wasn't like my wife, who is pretty shy and retiring, but she was determined we were going to get invited to the White House. So she said look and see what we could fly for the new President.

Well, it turned out he'd been Vice President during all the other Shuttle missions, and they'd flown everything under the Sun for him. So she thought about it for about a week, and finally she said, "Well, he's not the only person in the White House, fly something for Barbara Bush." I'm thinking, wow, she's pretty serious about this.

So I went to the rest of the crew, because we had everything stowed away in our personal preference kits. We were allowed 20 items in a personal preference kit, so I asked the crew if they had anything that wasn't assigned to anybody or committed to anybody. One of the crewmen had a little gold Shuttle charm that was available, so we all chipped in a few bucks and paid for that. So I told my wife, "Okay, now we got something we're flying, it's stowed, what do we do now?"

She said, "When the President calls during the flight mention it to him, and he'll invite us to the White House."

I'm thinking boy, she really wants to do this. I said, "He's not scheduled to call."

She said, "Well, he'll call, trust me." I'm thinking yeah, yeah, okay, so anyway I'm on orbit and I get this message saying the President's going to call. I'm thinking oh, this is spooky. During the conversation, they can see us; the crew families were over at our house watching this on TV. They can see us, and in a split screen they can see the President and the Vice President sitting behind him in this conversation. Of course, we couldn't see anything, we're just talking, and we're passing around the microphone, and my wife tells me later that she's saying, "Mike's not going to say anything, he's not going to say anything!"

And as we were signing off, the President was saying, "we're awfully proud of you" and so forth, and I said, "Well, thank you, sir, and give our regards to the new First Lady, and tell her we're flying something for her." He got all excited right there on TV. He said, "Well, that's fantastic, nobody's ever flown anything for her. I want you to come to the White House as soon as you get back and give it to her." So all the wives were jumping up and down. I'm thinking, I can't believe my wife had this all planned out.

Gets even better. Literally, two days after we landed, they flew us to DC. We were in a hotel the night before we were supposed to go over, and I get a call from Barbara Bush saying, "Would you mind coming a few hours early so I can give you a tour of the White House?"

I said, "I think I can make the time to do that." She was just fantastic, just charming as she showed us around, and she spent all the time in the world. If you remember, Millie was their dog and had had puppies. Big headline. So my wife, who is a big dog lover, came up with the idea to make a doggie biscuit in the shape of a Space Shuttle to leave for Millie. As we were going through all the guard stations you had to go through to get in the White House, everybody would open the box, they'd look at it, they'd roll their eyes, and hand it back to her. She left it in one of the upstairs bedrooms that was Millie's room. Just left it there.

So we got a wonderful tour, presented the gold Shuttle charm to Barbara Bush, and got to have pictures taken with the President in the Oval Office. I thought, well, that was really nice, that worked out just like my wife had planned.

About two weeks later when I am back in the Astronaut Office I get this message saying to please call the White House. I thought it was a joke. But they said, no, it really is a real message. So I called, and sure enough, it was the White House saying that I've been invited to a state dinner, just me and my wife. I thought whoa, what's this all about. The moral of this long story is when your wife comes up with a crazy idea, *listen*, because you never know what's going to happen. It turns out they had really been impressed with the doggie biscuit.

We go to the reception. I'm all dressed up in my Navy dress uniform, and she's in a floor-length formal, and we're standing in the reception line between Audrey Hepburn and Bob Hope, two of our favorite people. So my wife is just going, oh, it can't get any better than this. As the line is moving towards the President and the First Lady, and then to the Israeli Prime Minister and his wife, we were about five people away and I'm telling my wife, "he's not going to remember who we are," when President Bush looks up and says, "Mike, Diane." He immediately starts telling the Prime Minister about the doggie biscuit. I felt sorry for the two or three people that were still in front of us, because they got completely ignored.

At the dinner, they split up couples and I'm sitting between Audrey Hepburn and Bob Hope's wife, and the President's on the other side of Audrey Hepburn. He was really interested in the space program, so he kept leaning in front of her to ask me questions. I think she was getting a little bit irritated, because he was ignoring everybody at the table, talking about space.

At one point he says, "Well, when are you going to fly again?"

I said, "Well, I promised my wife I would just fly that second flight."

He said, "Well, do you want to fly again?"

I said, "Well sure."

He said, "Let me see what I can do." So he gets up, and walks across the room to where Diane was sitting. She was sitting between the White House Ambassador for Protocol and the wife of Vice President Dan Quayle. The President goes over and leans down and talks to her. At first she's frowning, and then she smiles. He comes back and says, "I think it's okay if you fly one more time."

I said, "What in the world did you tell my wife to make me expendable?"

He smiled knowingly and said, "That's between me and her."

After the dinner I go up to her, and say, "I really get to fly one more time?"

She said, "Just one more time."

I said, "What did the President of the United States tell you to make me expendable?"

She said, "He promised to invite us back to the White House." Which he did. But during the meal, I had said how nice it was that the families got to come up and visit. Remember, this was only the third flight after *Challenger*; there was a lot of pressure on the crews and the families. I said it was really special to be able to come up here and get a tour of the White House and added, "It's a shame every crew can't do that."

He said, "Well why can't they?" I said, "Well, you're the President." He said, "Well, so be it." So during his four years every crew and their families got an opportunity to tour the White House, which was really nice.

But so that's how I got my third mission.

Sounds like you got a directive from the President of the United States, right?

Yeah, that was pretty good. But I had promised that would be the last one, so after the third mission I had to make a decision. I had offers from NASA, the Navy, and industry. I had three good choices to pick from, and I wanted to go out and learn more about the business world. So I did. For fourteen years I worked for two or three companies, all of which merged into Lockheed Martin, so the last ten years I was with Lockheed Martin.

I was up in Denver, Colorado, as vice president there, really enjoying that. Current NASA Administrator Mike Griffin had been my customer on my last Shuttle mission, when he was the Deputy for Technology for the Strategic Defense Initiative Office. That was 18, 19 years ago. I got to know Mike then and had tremendous respect for him. He is extremely knowledgeable, a terrific engineer, loves the space program, and is as honest as anybody you've ever met, blunt. He called and made me an offer I couldn't refuse to come back to Houston and take this job.

My wife and I thought we'd live there in Colorado forever, I promised her that house would be our forever house, and she loved it up there. But it worked out really well, because our family is still here, the kids are here, now the grandkids are here, so she doesn't have any regrets about coming back.

So two years ago, little over two years ago, I became the Center Director. This is the best job in the world for me.

I have what I think is a wonderful time, a unique time, to come back and work in the space business. We are trying to fly out the Shuttle Program, and since I was here for a few years before the first Shuttle flight, it will be nice to be around as we fly the last Shuttle mission. I think that I'd like to be able to tell people I did that. We're building and finishing the International Space Station; and we're making the decisions on the Constellation Program.

Having three major programs in different stages of their lifecycle is unprecedented. It's pretty special to be a part of NASA and the space team as we're doing all these things, these three major programs.

Of course we got some small programs as well. But the decisions we're making nowadays on Constellation are pretty far-reaching. We're going to live with these decisions for 50 or 75 years. It is great to have such a talented group of highly motivated people work in these programs. It's a real privilege to be a part of the team here, because I think it's the best team in the world.

What is your vision for the Center?

I really do believe that the Johnson Space Center is—Mike Griffin has used the term—the premier Space Center. If you're just looking at human space flight, that's certainly true. The astronauts are here, they're trained here, the Mission Control Center is here. We are here to fulfill the mission that both the Administration and Congress have given us. Remember the Vision for Space Exploration initiative is not just the President's initiative. The Congress made it the law of the land with the authorization bill two years ago. We've been directed by the government and Congress to go explore the Solar System.

First step, of course, is let's go back to the Moon. But we're going to use both the Space Station and the Moon as a test bed to learn how to be self-sufficient and self-sustaining before we go blast off. Remember, we've never really had to be away from Mother Earth before. On the Space Station and the Space Shuttle, if something bad happens like a meteorite pokes a hole in the vehicle or something, you're an hour from home. You can do an emergency deorbit and be on the ground. On the Moon, you're two and a half days from home, and with the new system,

we're going to have an abort anytime philosophy, which says you're two and a half days from help. As soon as you fire the engines to go off to Mars or anywhere else in the Solar System, you're a couple years from home.

Now that's a different way of thinking. For the first time in human history, you're going to be truly self-sustaining. So we've got an awful lot of work to learn how to do it all — we've got to carry our own air and water and fuel and food and so forth, because we're not going to find it anywhere out there. If we're finding water throughout the Solar System, and there are more indications there are, we might have air and fuel and water in place. But we've got to learn to be self-sustaining, and we've got to learn to exist for long periods of time in zero gravity and what that means to the human body. We've got to overcome some things, and we're working hard on Space Station to do that.

The bone loss and muscle loss, the radiation effects, what zero gravity does to the human body for extended periods of time, very important to understand it and develop countermeasures for that, because we're not going to develop any artificial gravity any time soon out there.

I believe it's important for the human race to explore, and frankly get off Mother Earth. All of our eggs are in this one little basket, and we've got the capability to hedge our bets now, and we ought to be doing that. It'd be the ultimate shame if in fact a meteorite wiped out all life on Earth, which it does about every 65 million years. It may be another 65 million years, or it might happen tomorrow. But we've got the capability now to spread out through the Solar System. We need to start doing that.

It's a critical time. We've got a lot to learn. I really believe that the Johnson Space Center will, in essence, lead the NASA team in doing that. We've got the expertise in human space flight. We don't have the expertise in deep space operations, but we're teaming up and

working with the Jet Propulsion Laboratory which does have that kind of expertise. We have to learn about robotics, we have to learn about deep space operations. They need to learn about human space flight. So we're trying to team up with all the NASA Centers and choose the expertise that exists at each of the Centers and take advantage of that expertise.

The Johnson Space Center has experience first of all in human flight, but also in large programs—other Centers have program management experience, but they're smaller-scale than what we've got with the Shuttle and the Station and Constellation. We're going to lead, and we're going to be the integrator to pull it all together and make all the Centers work together. We won't be the Lead Center, but we're going to say we have to be the ones to make sure the team works together to be successful. And it really has to be a team effort with all the Centers working together.

We've made tremendous progress in the last couple years. Mike Griffin has stressed that more than anybody ever has. We've got to include our international partners as well. We certainly want our domestic access to space if we're going to be a spacefaring country. We don't want to abandon that capability for any extended period of time. But any space effort like the International Space Station, like Constellation, will be an international partnership. We've got that precedent set now with the International Space Station.

In industry we worked a lot with international partners, because we've all become part of a global economy, and so we do that naturally. One of the things that's delighted me coming back to NASA is seeing how far NASA has come in working with European Space Agency, the Russian Space Agency, the Canadian Space Agency, the Japanese Space Agency. They're all partnering, and learning how to work with international partners is a skill and a core competency that you need to nurture and continue, because it is extremely valuable. It doesn't come naturally

to us. You have to understand what's important to them in order to work effectively as a team. We want their participation.

The space program brings the world together and gives everybody a common cause and a common set of objectives. You don't agree on everything, but everybody wants to be a part of this. It's wonderful to be working together.

Johnson Space Center will not only lead the agency if you will, pulling it together as a team, but all the international partners as well. We are well positioned to do that. Now that's a huge responsibility. It really is. Somebody has to be the integrator, and you can move the work out to all the Centers.

Of course in industry you do it naturally. You have a lot of other contractors on any team, and invariably on a big effort you're spread around the country. The prime integrator has to pull it all together and make sure nothing falls through the crack. All the pieces have to fit together. Well, that's what JSC's job is going to be in the future, is to make sure nothing falls through the crack, that it's all pulled together and functions smoothly within the agency and then with the international partners as well. I think we've got the talent to do that. We've got to make sure we train our people appropriately to do that, to be good program managers and project managers, and international partners, to pull it all together. The technical side of it I don't worry about. We do that very very well. The program management side of it, the political side of it, is something we've got to continue to work on very hard.

What changes have you seen in NASA since the time that you first started? What changes are occurring that will move NASA into the future?

There were a lot of stovepipes back then, a lot of rivalry between Centers. It got so bad after *Challenger*, you didn't even talk to other Centers readily. Mike Griffin has tried very, very hard to break down those walls. I see the NASA team working better together, the Centers working better together, dramatically better than I saw when I left NASA in 1991. Now I know all the Center Directors. I've known them all for years. I know most of the folks at Headquarters on Mike's Headquarters team. We talk all the time.

We have a monthly Strategic Management Council at some Center. We move it around. Everybody comes together face to face. It's a lot of travel, it's exhausting, but it really facilitates communication. You work as a team. I have no reservations about picking up the phone and calling any other Center Director, anybody at Headquarters, and say, "hey, what's going on here? This doesn't make sense, let's understand this." That's fundamental to communications. You have to have the relationship first so you can communicate. That hasn't been the case in the past all the time.

That teamwork is a dramatic change from the way it was in 1991 when I left. Now we're still working it down. Middle-level managers are not as team-oriented as the senior managers, but I see it filtering down. Mike Griffin gets the credit for that. He has insisted on that. He has moved people between Centers, between Centers and Headquarters and so on. So you're not quite as parochial. You can at least have an appreciation about what the other Centers do and what Headquarters does, and that's good for teamwork. We've always emphasized mission success and that's one of NASA's four core values, but teamwork is one of those four core values too, and they're very serious about it. Safety and integrity are the other two. So a big change is the emphasis on teamwork that I didn't see before. One agency working together, and the teamwork again with the international partners.

It's an appreciation of what other people can bring to the table. We're trying to get rid of the "not-invented-here" attitude. We're accused of being arrogant here at the Johnson Space Center. Sometimes that's well deserved. But I see people opening up their minds and saying that they'd like to learn what else is going on out there.

I came in and started emphasizing and requiring benchmarking against not only the other Centers but outside NASA as well, emphasizing the value of diversity in a workforce, because I think it is more creative and innovative, and I see people starting to get much more excited about that, enthusiastic and accepting of that, which makes the team work better together.

What lessons learned do you apply to your current role as Center Director?

The biggest—and it's a struggle—is you have to encourage people and create an environment where people feel free to speak up. I've been delighted at what I have found. I came back to NASA a couple years after the *Columbia* [STS-107] accident. The agency had invested a huge amount of resources and emphasis on people to feel free to speak up, and to feel a responsibility to speak up.

We have a structure now, whether we're talking about the Program Requirements Control Boards or the Flight Readiness Reviews or the Mission Management Teams—they're very structured where you actually actively seek out dissenting opinions, asking, "are there any alternate opinions? Let's hear them." That's good. This is tremendously time-consuming, but time well spent so we get all the opinions in there.

On the tough decisions you're always going to have—it's a 51-49 type thing. There will be strong opinions on both sides of any argument, any difficult topic if you will. So you need to get people feeling like they can speak up and should speak up, have to speak up.

The other side of that is when you finally have to make a decision—and sometimes the decisions go all the way up to Mike Griffin—you also have a responsibility to explain your decision. If you don't take the time to explain your thinking, your rationale, the people that spoke up and weren't agreeing, they won't speak up the next time. So I have to take the time to say why I'm making this decision. I've learned if you take that time then the people that weren't agreed with or felt like they lost the argument will speak up again the next time, as long as it was explained to them. They may not agree with your rationale, but at least you paid them the respect of saying here's why I made that decision. That's time-consuming. It's hard to do.

We're still in a mode post-*Columbia* where people are taking the time, but I've seen it happen before *Challenger*, before *Columbia*, the pendulum swings back, and people get complacent. They try to expedite things and short-cut things, and they don't give people the time to speak up. We'll get there again. It's probably inevitable. That's just human nature. We need to fight that as much as we can. We need to emphasize an environment and a responsibility to speak up. It is about communications more than anything else.

Now I've seen it in industry. We had a period of time at Lockheed Martin back in 1999. We had five different failures—two Mars missions, two Titan IV-B classified missions that cost the government billions of dollars. Then, another rocket failure. It was a disastrous year. We did a lot of soul-searching after that. It always came down to a failure of communications.

Communications is the hardest thing we as humans do, especially when you've got a large team, and especially when you've got very highly technical work that you're trying to do. You've got to create an environment and a process where again, people feel a responsibility to speak up, not just an ability but a real responsibility. I stress to the new hires when they come in, “You are now a professional, a space professional. You may be only 22 years old, straight out of

college, but you're right now a member of the team, and you have a responsibility to speak up. Ask dumb questions, because you've got a fresh perspective.” You'd be shocked how many times a young person will ask a question and we'll go, “I don't know.” We hadn't thought about it that way, because we tend to get set in a way of thinking.

So we seek a fresh perspective. One of the things we've learned about diversity—and we're trying to stress that here, is it's not so much the gender, the color of the skin and so forth,—it's the way you've been trained to think or approach a problem. Engineers are trained one way, test pilots are trained a different way, scientists are trained a different way, medical doctors are trained a different way. The thought process is different for each.

So when there's a problem, we have many ways to think, how do I solve this problem? That's a wonderful thing, because I saw it work in my class of astronauts, where we had such a variety of differently trained thought processes and constantly people would just say, “Why? Why are you doing it that way?”

Test pilots all tend to think alike. We've been trained alike, and there's a reason you train test pilots to think alike—so there will always be a backup plan. The scientists have a different plan. The scientist would say, “Why are you doing it that way?” We'd answer, “Well, here's why.” They'd said, “Well, how about this, have you thought about that?” We'd say, “No.” Because everybody was equal in the 1978 astronaut class and nobody was senior, there were times when the discussion was really a free-for-all. But it was fascinating to watch the interchange, the different ways of thinking.

Right now, I think communications are very good. But it's going to change. The challenge really is how do we fight that, how do we fight complacency. Success brings

complacency. That's human nature. I've seen it happen several times now. Trying to figure out how to fight that is our biggest challenge.

What do you think NASA's role is in society? What is its impact?

I feel very strongly that the space program is important to our society for several reasons.

Number one, all the polls indicate the public is very proud of NASA and the space program. Now, they don't know what we do. When you ask them specifically what does NASA do, they don't know. We had industry conduct a bunch of surveys, focus groups, at NASA's request. What we learned is, well, a lot of people knew about the Hubble Space Telescope, a lot of people knew about the two Mars rovers, very few people knew about the Shuttle. Fewer knew about Space Station, or knew that we even had one. Nobody knew about this Constellation Exploration Program.

So, they don't know what NASA does or what NASA is trying to do, but they have a very high opinion of NASA. We're rated the highest in the public opinion of any government agency by far. They're proud of what we do. They think we do that high-tech stuff, and that's pretty cool. But we don't do a very good job of educating the public about what we're doing.

But I do believe that the economy grows and society improves because of technology. I was both a math and a history major, and I love history books. When you go back and read about the 1920s and '30s, people had radios, but information was shared from "hand-to-mouth" for an awful lot of people. A neighborhood might have one radio. People would gather around to listen to that one radio. Well, now everybody's got a TV. There are actually two TVs for every human being in this country, believe it or not.

Food is cheaper. Believe it or not, energy is cheaper, even though we complain about the price of oil and everything associated with it. Technology has made life cheaper and easier, even for the poorest sections of society.

This is not to say that we've solved all the problems. We haven't. But despite what you read in the media, by almost any reasonable measure, life is getting better. It's getting better because of technology. We have things to solve, the energy problems, the global warming, things like that. Politics is always going to be a problem. But the fact is, the standard of living is rising for the vast majority of the population. You have to go back and compare to what it was 75 years ago to really understand that. And the reason is because of technology.

Now NASA really is the example of what the country ought to be doing—investing in technology, research, and development. I could talk forever about the spin-offs from the space program. Communication satellites, cell phones, Global Positioning Systems. We take them for granted now, but they're spin-offs from the space program. The Apollo Program, going to the Moon and the need to miniaturize everything, had a dramatic effect. Transistors, the computer chips, all that was really started because of the space program.

We made a huge investment for the forty years of the Cold War. We invested 11 percent of our federal budget in research and development to one extent or another. The Apollo Program was one example of that. It drove the Soviet Union into the ground. They couldn't keep up. Our economy just skyrocketed. And it's still robust. But in 1991 when the Soviet Union collapsed and we weren't racing anymore, we cut back to three percent of our budget in research and development. NASA's budget is part of that three percent. Other countries figured out that that investment was a good deal. They're making huge investments now. China.

I'll give you some statistics. In 2004, we graduated 70,000 engineers in this country, which is half of what we graduated back in the early 1990s. We graduated 70,000, India graduated 350,000, and China graduated 600,000 engineers. So between India and China, there are more than ten times the number of engineers we graduated. Guess what? They're staying home and working in those countries, because the jobs now are there.

Fifty-nine percent of the PhDs in this country for years go to foreign students. They used to stay here and work. They used to stay here, start new companies, create jobs, create whole new businesses, grow our economy. Guess what? Now they go home, back to their countries, and start those new technologies, new companies, new jobs in their countries, for a lot of reasons. One, the jobs are there in their countries, their countries are making the investments. Two, after 9/11 [2001], it's hard for a foreign student to get security clearances over here.

We are in essence educating the global competition. We still have the best university system in the world. Most people send their kids over here to get a good technical education. Then they go back home. My point is the economy that we enjoy, the world's most robust economy, is a result of the investments in technology that we've made, and the space program was a big part of that.

To get kids interested in technology, you need to get them excited about something. They get excited about space. "I want to be an engineer, I want to be an astronaut so I can work in the space program." You talk to a lot of the folks around here and they will tell you, "Oh yeah, I decided to be a mechanical engineer, an electrical engineer, an aerospace engineer because of the space program. I wanted to work at NASA."

I talk to the young kids in school a lot and have over the years, once a month. This past year, I haven't been able to, but for twenty-five years I've gone to schools about once a month,

and I see the kids get really excited about the space program. But you don't want to scare them off. Math and science and engineering can be scary. They're not easy subjects and you want to get the kids excited about them. You have to make the kids comfortable and say, "hey, this is an interesting thing, the space business is fascinating. Technology is fascinating. Don't be scared of it. Don't be afraid of it." If we can make them comfortable with it so they take a serious look at it, we'll be amazed at the number of them who say, "wow, that's really pretty good, that's fun to do," and we need kids to do that. You've got to reach them in the middle-school years. You can't wait till high school. That's hard to do sometimes.

This is a pretty special place to work, and you need to transfer that feeling to the kids somehow. If these jobs aren't available, if that attraction is not out there, people aren't going to go into engineering. As a country, we are going to abandon the playing field to international competition, and watch their economies take off, and they are taking off. Ours will stall. It is just like night follows day.

China's economy, right now at current rates of growth, if it continues, and a lot of people think it won't—at current rates of growth, in 2025 they will have the world's largest economy. They'll pass us by like we're standing still. We're not growing like we used to, because we're not making the investments we used to. It's really simple. But since we're the only superpower and the world's largest economy right now, nobody really cares. By the time they care, it'll be too late. That worries me, because I want my grandchildren to have the same opportunities that I've had here.

The space program is just one example, but a very good one, of how you attract people into the engineering and sciences. If you don't do that the economy will suffer for it. It is really simple.

Why would you encourage someone to come to work for NASA?

The best thing a person can do for a career is find a group of people that enjoy doing what they are doing and work with them. And I really believe the folks here like what they are doing and believe it is something that's important for the country. They're really proud of what they're doing. We don't have a whole lot of space programs out there. NASA is the only one we've got in this country and I believe this is the best group of people in the world. We all have tremendous pride in our space program and what we've done.