SALLY RIDE Former Astronaut, NASA

The Greatest Challenge Facing Humanity

MEDALLION SPEAKER SERIES

Photos by Paul Eric Felder

The first American woman in space lays out why encouraging the education of girls in math and science is crucial for American society in the 21st century.

Thursday June 16, 2005

When astronaut Jim Lovell of Apollo 13 fame was circling the moon, he looked back at Earth and called our planet "a grand oasis in the great vastness of space." That's extremely unusual eloquence for an astronaut – you're not going to hear any more of that this evening. When given the title, "What Is the Greatest Challenge Facing Humanity?" I first decided not to give this talk. Then I decided I could probably turn this around a little bit and talk about the greatest opportunity for humanity: education. For individuals anywhere, education leads to opportunity, and education lights the path out of poverty and despair. For nations, an educated and motivated workforce is the key to a competitive advantage in a global economy.

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The United States woke up to this in the 1950s. Deep in the middle of the Cold War, the world was shaped around the struggle between two superpowers: the United States and the Soviet Union. It was a struggle for international influence, prestige and power. The United States viewed itself as technologically superior to the Soviet Union and assumed that, in any potential conflict, our technological advantage would carry the day. Then one day in October 1957 we got a surprise. The Soviet Union launched Sputnik, the first satellite put into space. Nothing had ever been in space before; the Soviet Union had successfully launched a rocket with a satellite on board, and we couldn't. Suddenly, we weren't technologically superior. And if their rockets could carry a satellite into orbit, their rockets, we realized, could carry nuclear weapons to the United States. That deeply affected the psyche of the nation, from California to Iowa to Maine.

The nation's response was swift and dramatic, and it focused on substantially and visibly increasing our science and technological competence and capabilities. This led to a number of things, including the formation of NASA shortly after, and to a nationwide emphasis on science and math education. Science and math education was transformed in the schools, and the country elevated science and engineering to nationally important status. Today, the challenge from overseas is just as real.

The launch of Sputnik was a single galvanizing event that was very dramatic; it came with banner headlines. The satellite orbited earth with a little radio transmitter (a brilliant public relations move by the Soviet Union) that beeped, and amateur radio enthusiasts in the United States could literally listen to the satellite going overhead so everyone in the country knew about this.

Today's economic challenge has been sneaking up on us, in comparison. But over the last several years, we've lost our competitive advantage in science and technology. Other countries put far more emphasis on education, particularly science and math education. They have people who are just as smart as we are, they're educating and training them just as well as we are, and they're doing so in huge numbers. They're building an enormous competitive advantage. It's time for us to wake up, remember what we did in response to Sputnik, and again value and emphasize science and math education.

Carl Sagan has said, "It's suicidal to create a society dependent on science and technology in which no one knows anything about science and technology." Science and technology are the engines that drive our economy – and it is stupid to put so little value in science and math education.

Ride's Path into Science

I was always fascinated by science from the time I was younger than almost everybody in this room. In second and third grade, science was my favorite subject in school. I was an avid tennis player, so when I wasn't in school, I was out on the tennis court. But when I was in school, I loved science. I remember being in class and having our teachers wheel in big, black-and-white TV sets so that we could watch some of the early space launches. We were all fascinated – we all dreamed of going into space someday;

it really wasn't unusual then for kids to dream about being scientists, astronauts, doing a whole variety of things. It's not unusual today, either.

There was a study not long ago of fourth graders in this country. One of the questions was, "Do you like science?" That was the way it was worded. Sixty-eight percent of fourth-grade boys said they liked science; 66 percent of fourth-grade girls said that they like science. We start to lose both boys and girls starting in fifth, sixth, seventh grade, but we lose girls in far greater numbers than we do boys. Kids have the interest, but our society and our schools do a great job of squelching that interest in far too many kids.

When I was growing up, my parents encouraged my interest in science; neither were scientists, they probably couldn't figure out how they ended up with a daughter who had such interests in the planets, animals and stars. But that was good enough for them; they encouraged me. I went to public school through ninth grade; for 10th, 11th and 12th grade I went to an all-girls school – not because my science education would be better, or for any philosophical reasons, but because they had a tennis team and they gave tennis scholarships. It was, in retrospect, a very lucky thing, because there the expectations were that girls would take science – that they would

"Launch is an exhilarating, mind-numbing, bone-rattling eight and a half minutes."

do well in science. Girls were encouraged to take physics, trigonometry; that was not true nearly so much in public schools at the time. I had two science teachers who spent a lot of time with me; they were good teachers, they taught me a lot of science – but that's not what was so important to me. What was important was that they built my self-confidence and made me believe that I could go on to college in science if I wanted to. So I did.

I went on to Stanford, got a degree in physics, went to graduate school at Stanford in physics, and I was just a couple months away from finishing my Ph.D., sitting in the cafeteria on a Tuesday at about eight in the morning reading the student newspaper. I remember to this day opening *The Stanford Daily* and seeing in the corner of page three an ad NASA had put in the newspaper, and college newspapers all around the country, saying that they were looking for applications for the astronaut corps. This was a big deal at the time. NASA had not selected any new astronauts at all in over 10 years. So there were 10 years' worth of people waiting for the opportunity to apply to the astronaut corps. But it was important for another reason: This was the first time that NASA had said they were going to bring women into the astronaut corps. They were actively seeking applications from women, and they put ads in places like the Stanford student newspaper and corporate newsletters so qualified women would find out and know they could apply.

The moment I saw that ad, I ripped it out and checked "Yes, I'm interested," and stuffed it in the first mailbox I saw on my way back to the physics department. A lot of other people did the same thing; about 8,000 of us applied. Out of that group, NASA picked 35 to be the first class of space shuttle astronauts – who would join the 20 or so astronauts who'd been around for over 10 years since the Apollo program. That group of 35 is pretty representative of what NASA was looking for – and is still looking for today. The group included 15 astronauts with a test-pilot background and 20 with science and engineering backgrounds. That's about the ratio of the astronaut corps today: 40 percent test-pilots, 60 percent scientists and engineers. That group also included the first six women, and today the astronaut corps is between 20 and 25 percent women.

My father was without a doubt the happiest person on the planet when I was selected to be an astronaut. My father was a political science teacher at Santa Monica Community College. He had a daughter who was about to get a Ph.D. in astrophysics – but my father did not know what astrophysics was. He could not explain to his friends what his daughter was about to do for a living. Then I became an astronaut and my father's problems were over.

I packed my bags after I got my degree, moved to Houston and got in line for my turn to fly in the space shuttle. My turn came on STS-7, the seventh flight of the space shuttle, on board the Challenger. I got a chance to rocket into space from a standing start on the launch pad to 17,500 miles per hour in eight and a half minutes. Launch is an exhilarating, mind-numbing, bone-rattling eight and a half minutes; it's an amazing experience. When the engines cut off, I was weightless, I could float in the middle of the cabin, I could do 32 somersaults in a row if I wanted to. We were traveling five miles a second, which means it took only 90 minutes to go all the way around the world once. But the most spectacular part of the flight (weightlessness is the most fun)is the view looking back at Earth. I got to look back at

Clockwise from top left: Club Executive Committee Chair Robert Saldich, Sally Ride, Ginny Saldich, Meg Dudley, Mackenzie Mills, Lindsey Dudley, Madison Mills and Drew Dudley. Any future astronauts in the front row?

the San Francisco Bay, I could see the Stanford Linear Accelerator Center, the snow over the Sierras, the crystal blue water of Lake Tahoe, the smog over Los Angeles. I could see coral reefs off the coast of Australia, deforestation in Madagascar; it was an absolutely breathtaking view – and one that brought home the fragility of our planet and how important it is that we take care of it. All you need to do is look out the window of the space shuttle towards Earth and you can instantly see the effects that humanity is having on the planet.

I was the first American woman to go into space, but now of course, it's common for a woman to be on board a space shuttle. Over 30 different American women have gone into space on the space shuttle. Almost every flight that goes into space has at least one, often two and occasionally three women on board out of a crew of five to seven astronauts. On the next flight there are going to be two women, and Eileen Collins will be the commander of that flight. It will be the second space shuttle flight that she's commanded.

To the Moon, Alice

Take a look around the technical workforce, including NASA, and you'll find that women are still significantly underrepresented. They make up about 11 percent of engineers, 20 percent of scientists. Those percentages are way up from 1970, but they're still very low. Companies are trying furiously to recruit more women into the workforce; they know that it is to their advantage to make full use of the available talent pool. But when they go to universities to recruit – to Stanford, Berkeley or UCSD, where I teach – they find that women aren't coming out with degrees in nearly the numbers they would like and could easily absorb. They're coming out with degrees in humanities, biological sciences, languages, a variety of fields – but not with degrees in engineering and physical sciences in the numbers that companies would like. They talk to university professors and say, "Graduate more of them!" The university professors say, "We'd love to, and we admit that we lose our share, but they're not coming to us out of high school in the numbers that we would like and declaring science majors."

The problem starts early on. But remember that in fourth grade, as many boys as girls were interested in science and math, and that's been true for a long time. But in middle school, we start to lose both boys and girls – but girls in far greater numbers. The reasons aren't because they've lost interest; in fourth grade, they were fascinated by science. In fifth grade, they're still interested in it; they haven't lost their aptitude for it in a year or two, but societal effects start creeping in. Now we don't have the overt obstacles to girls and women going into math and science anymore – those are long gone. But there are still subtle societal stereotypes that creep into kids' thinking.

Imagine an 11-year-old girl who says she wants to be an electrical engineer; she might still get a very different reaction from her peer group, maybe even her teacher. She might start to wonder. It may not be cool for a girl to be the best one in the math class by the time she gets to eighth or ninth grade. There's been a lot of research that shows that some – not by any means all – girls do start to dumb down and pretend they're not as smart as they are as they go through middle school and on into high school. And there are still lingering stereotypes out there that our culture enforces. If you ask a boy or girl to draw an engineer, they will draw a geeky, old male with hair like Einstein, a lab coat and a pocket protector. This is not the image that 12-year-old

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girls aspire to, or many 12-year-old boys for that matter. We need to change the image that society imposes of scientists and engineers. If you think that this is not a problem, let me tell you a story.

Three or four years ago, I was giving a talk in an affluent suburb of Washington, D.C. At the end of the talk, a woman came up to me with her 12-year-old daughter to tell me what had just happened to her daughter in school. Her daughter had wanted to be an astronaut for five or six years, had gone to space camp already, several times, knew the thrust of a J5 engine; she knew more about the space program than I did! She was taking a math class where they had just started learning probability, and they'd had a quiz the week before. One of the questions on the quiz was: "I will go to the moon someday. A) Very probable B) Possible C) Improbable." She, being sort of a realistic person, put "probable" as her answer. The teacher marked it wrong and wrote the reason in the margin – and the woman had this test to show me: "Women can't be astronauts."

Where had this teacher been? My first flight was in 1983. This was 2000 or 2001; 30 women had been up in the space shuttle. More to the point, how many girls has that teacher influenced over the last 10 or 15 years? Fortunately, that teacher is in a minority, but the people are still out there.

Sally Ride Science

Three years ago, I started Imaginary Lines, which we now call Sally Ride Science, to try to keep those girls involved. Our philosophy is we don't have to convert any of them; they're already interested in fourth grade, we just need to foster their interest, give them support and sustain their interest. We want to create events and programs that are designed to be fun, that the girls can participate in with their friends, where they can participate in hands-on activities, and where they can meet female role models representing a whole array of science and engineering, to put female faces on these careers. We run summer science camps, including one at Stanford, for middle school girls; these are very

popular. We do one-day science festivals for girls all over the country: MIT, University of Michigan, one at NASA Ames this fall – we're just settling on a date now. We also publish science books that feature biographies of real, living female scientists and engineers. All this is to create a sense of belonging in science, so these girls don't feel it's not natural for them to have these interests – because it is.

Why should we care whether kids, especially girls, go on to become scientists and engineers? It's critical to our competitiveness to have a technically trained workforce and technically literate citizenry. And if we don't draw on our entire talent pool, then we just don't have a prayer of achieving our potential. But some recently have said women may not be natural scientists. Of course that's ridiculous. Let's illustrate how ridiculous by putting their participation in perspective.

Go back to 1970: 5 percent of law school students were female, 8 percent of med school students, 4 percent of business school students; only one in 27 – less than 4 percent – of high school girls participated in sports. You could have concluded in 1970 that girls didn't like sports or they'd be participating. You could have concluded they didn't make good lawyers or they'd be going to law school; that they wouldn't make good business people or didn't enjoy business or they would be going to business school. In fact, our society had simply not been encouraging women to go into those professions, and those professions carried a male image; they weren't welcoming to women. Subjects like physics and engineering were much lower in numbers – less than 1 percent – in 1970, so they've had farther to go. Today, law school is just about 50-50 male and female, med school about 50-50, business school about 50-50, and 40 percent of high school women participate in sports. Clearly they had the aptitude and interest for those professions, and it would be ridiculous to say women can't be doctors; no one would say that. But with physics and engineering, people are still saying, Maybe they're not cut out to be physicists or engineers. That's because the stereotypes were much more deeply ingrained. The numbers have increased unbelievably; in 1970, you could have rounded up 100 engineers and it's very possible none of them would have been women. Now 11 percent of engineers are female – an enormous increase, and that trend has been continuing upward. Why should we think that all of a sudden that line is going to flatten out and forever we're only going to have 11 percent of our engineers be female? That line is going to keep going up just the way that it has in so many other fields.

There are lots of kids out there, both boys and girls, who can go on to do great things, including in areas of science and engineering. They just need support, encouragement, role models and access to a quality education. The vitality of our society depends on our ability to inspire and to educate them. It's up to all of us to elevate the value of science in our society, and if you think that the messages that our culture sends don't have an impact on kids, let me close with another true story.

There was a lot of publicity surrounding my first flight – so much that you would have concluded I was the only person on the crew. About a week after my flight I was sitting in a restaurant in New York having lunch with a friend, and a woman neither of us knew came up and sat down at our table and said that she had a story she wanted to tell me. Her five-year-old boy had, about three or four months before, discovered space. He wanted badly to be an astronaut, and he read everything that he could about it. He made her buy him a flight suit so that he looked like the astronauts. He was studying up on the space shuttle and the space program. He had a calendar and was marking off the days to our launch. The morning of the launch, he got his mother out of bed very, very early – our launch was at 7:30 East Coast time – so she had to watch the whole countdown from the time we got into the space shuttle. Finally we hit T = 0, we launched, his mother said thank goodness, went into the kitchen to just kind of go about her day, and a couple minutes later, she heard her son crying in the living room. She came racing back into the living room, she said, "What's wrong, is the space shuttle okay, are they all right?" He said, "Oh, they're fine, they're fine, the engines are still going, but they're fine." And she said, "Did you hurt yourself, is something wrong?" He looked up at her and said, "Mom, can little boys grow up to be astronauts, too?"

Question and Answer Session

Q: We heard about your father and how he felt about you becoming an astronaut. How did your mother feel?

A: My mother was not quite sure how to take the news when I told her that I was accepted to be an astronaut. But she became my greatest supporter before and during the flight. She was very proud of me and my accomplishments. She was not a scientist but became very interested in science and the space program as a result of my involvement in it.

Q: How did it feel when you realized that you would become the first American woman in space?

A: I went into the astronaut program for the same reason all astronauts do; I wanted to get a chance to do that and to go into space as soon as I could. I was thrilled to be chosen as early as I was for a flight; I was one of the first four from that group of 35 to go into space. We all went up on that same flight, STS-7, but it really was a special honor to be picked to be the first woman to go into space, to represent the United States in space. It's something that I'll always be very proud of; it made that flight very, very special for me.

Q: Did you notice any physical changes to your body as a result of being in space?

A: Yes, your body loves being weightless and it adapts remarkably quickly to what is a totally different environment. We all evolved in 1-G. Our brain has been coordinating movements of arms that weigh this much, a head that weighs this much, legs that weigh that much – since we were born. But your brain adapts right away, so your movements are very coordinated even from the beginning, which just shows how remarkable our brains are.

Your body begins to adapt in several ways. One of the most interesting thing is that astronauts grow an inch, and it happens very quickly, over the course of just a couple days; you can actually measure it. When you're standing on Earth, gravity's kind of pulling you down. Your spine is made up of vertebrae, which are bones and soft, squishy cartilage in between. On 1-G, you're being pulled down, so the cartilage is all squished and protecting the vertebrae from rubbing against each other. But in zero gravity, you're not being pulled down, so this cartilage expands and you grow; I was five foot seven for 16 days of my life. Sadly, it's reversible, so it's not a solution for would-be basketball players.

There are other, more serious adaptations. One that's very important for long-duration space flight is that, because you don't need your bones, your body starts adapting to that. Even while you're sitting in this room, your bones are constantly being reinvigorated; you're constantly losing bone and creating bone, it's a continuous process. In orbit, your system has figured out that you're not using these bones, so it continues losing bone but it stops creating bone. The result is that you basically lose bone mass almost as soon as you're up there, not really very much, at almost a linear rate for as long as you're there. For potential missions to Mars, that's a concern. You'd still have bones when you got to Mars, but they'd be rather brittle. NASA is working hard to try and find a solution to that problem.

Q: Continuing the theme of the body in space, we've had a large number of questions relating to what space food tastes like.

A: You'll be happy to know that those of you who asked that question are not alone. Six months after my first flight, I was invited to give a physics colloquium at MIT. When you're invited to give a physics colloquium at MIT, you work hard preparing the world's best colloquium. I prepared what I thought would be a tour de force technical description of the space shuttle and the space shuttle program, and when I finished the lecture, which was maybe not too brilliant, but not too bad, the first question I got after this technical presentation was, "What does the food taste like in space?" The answer is it's not so bad. A lot of people still picture astronauts as squeezing food out of tubes; we don't do that anymore. We haven't for quite some time; if you're going up in the space shuttle, you can actually take some fresh food with you. We took apples and oranges, a jar of peanut butter and a loaf of bread. But that doesn't last very long, and then you get into the dehydrated, irradiated food; that is a lot like food that you take on a long camping trip. You need to add water to most of it to re-hydrate it, but it's not too bad.

Q: A number of questions about the amount of teamwork required when you're up in space. Is there a story that particularly sticks in your mind about a difficult or a challenging situation you faced while on the shuttle?

A: Teamwork is key, and the picture you should have of just about every task in a space shuttle is that there are often two, sometimes three astronauts involved. There's always someone who can take over a task if there's any reason to. Reasons might be that one astronaut is just very busy and doesn't have time to get onto the next thing, and somebody else needs to be able to take it over. One that sticks in my mind that required a lot of teamwork was from my second flight.

We had lots of little things go wrong on that flight. We were constantly repairing things. One of the things that we had to fix was the communications antenna on the outside of the space shuttle. We had a planned space walk anyway, so when the astronauts were outside, they were going to do some things to move the antenna around, and we needed to do some rewiring inside to try to fix things while they were moving things around. Mission control sent up a detailed message on how we were to rewire this connector. We had to, among other things, rewire a 36-pin connector; that takes a little while. Two of us spent hours rewiring (in weightlessness – floating wire-cutters and everything) a 36-pin connector while the astronauts outside were maneuvering the antenna. I was doing one side of the connector, Dave was doing another side, and we were each going from our instructions up from mission control. It came time to make the connectors – astronauts are outside, they're floating, they have so much oxygen in their space suits, the clock is ticking – we went to make the connection, we looked at each other, and mission control had sent up instructions to wire two male connectors. And we just went "Ahhh!" – and dove back in and rewired one of them in about half an hour.

Q: We heard about your views on education and the need to inspire children, and that has inspired a number of questions that relate to your views on the declining scientific literacy that we're seeing in this country and how that impacts the ability of this country to be able to make wise investments in research and development.

A: It's critical today that we have scientifically literate citizenry. All you need to do is open the newspaper to see that science and technology affect our lives every day – and decisions that we make every day. How are you supposed to know how to vote on a variety of issues if you

don't have some basis in analyzing the issues that are before you? We've got issues like global warming, environmental contamination, medical research, a whole variety of things that face the citizens of this country and the people of the world. Without that basic background in science – which probably more than anything gives you the ability to analyze a situation, to analyze a subject – we can't expect our citizens to make informed decisions. It's very important to put a renewed emphasis on science education – if not to create scientists and engineers, to create a scientifically literate population.

Q: Should we be spending many dollars on going into space when there are problems here on the home planet?

A: I've been asked that one many times, and my answer is that I think we should. It's very important for any country to have a forward-looking view, to have something for its citizens to aspire to; our space program is one of the things that we have in this country that represents the best that we can do when we put our minds to it. It shows what we're capable of achieving. The space program does more than most things I'm aware of towards inspiring our youth today to pursue science and math. There are lots of kids out there who are fascinated by exploring the unknown, by exploring the planets. Is there life on Mars? Are there planets like Earth outside our solar system? Are we alone in the universe? These are fascinating questions, and if you don't look towards the future and explore those questions, then you really become a stale society.

Q: Describe an experience you've had in space or as a result of your adventures that has moved you, either emotionally or spiritually.

A: The first thing that comes to mind is one of my first views out the window of the space shuttle, looking back at Earth. I was struck, as all astronauts are, by what I saw. I could look off toward the horizon to see the curvature of the Earth, and see a very thin, royal blue line right at the horizon of the Earth. It took me a little while to figure out what that thin blue line was. Then I realized that it was Earth's atmosphere, and that that was all there was of it; that was all that separated everything we know on our planet from the blackness, the vacuum, the emptiness of space. It instantly puts into perspective how fragile our planet is.

Q: What do you think you would have been doing if you hadn't become an astronaut?

A: I would be a physics professor someplace. Maybe at UCSD. That was what I was planning to do when I was in graduate school. When I applied for the space program, I was applying for post-docs. I got the ultimate post-doc.

Q: Is there life elsewhere in space? Is it out there looking back at us?

A: I don't believe it has visited us yet, so I'm not a believer in aliens. But I think that the odds are very good – and we're discovering all the time how good they may be – that there is life outside of Earth and potentially intelligent life outside of our solar system. Inside our solar system, there may well have been very primitive life on Mars. The key to life on our planet was the existence of water. We've learned over the last couple of decades that life can begin relatively quickly on geological timescales, and that once it begins, it's hard to get rid of it. It can adapt to conditions we could not even imagine living in; we've seen many places on Earth. That's made us appreciate that maybe we should be expanding the way we think about possible habitats for life. If there was water on Mars – which we now know there was, from the two Rovers up there now – maybe primitive life started on Mars. And maybe it has survived. Mars is probably the most likely place in our solar system to find some other form of life. It won't be intelligent; it will be very, very primitive if we do find it.

If you look outside our solar system, we now know that not only are there billions of stars very similar to our sun, but planets around stars are common. We didn't know until just about 10 years ago, for certain, whether there were any planets around any other stars. They were so small and far away that we didn't have the technology to detect planets around other stars. Now our telescopes and measurement techniques have gotten good enough that not only are we finding planets, we're finding a bunch of them. We found over 150 planets in the last 10 years or so. We can still only find the very big planets – Jupiter-size planets, Neptune-size planets. But our technology is getting better, and just this week we had another breakthrough where a planet considered Earth-like was discovered, in the sense that it's a rocky planet twice the diameter of Earth, about seven times the mass of Earth; it's very close to its star so it's really, really hot. This is a bad place, there's nothing there. But we're getting to the point with our capabilities of maybe being able to detect, in the next five or 10 years, planets around other stars that are about the size, maybe in about the place, of Earth. There are probably lots and lots of them out there. If life can start relatively easily, then maybe it's started on some of those planets. There was a scientist from NASA Ames involved in that discovery – Jack Lissauer.

Q: Will the first person on Mars be a woman?

A: Yes, and I hope that she takes me with her. Ω

This program was made posssible by the generous support of Koret Foundation Funds.