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STEM EDUCATION AND FUTURE GENERATIONS OF AMERICAN INVENTORS, TECHNOLOGISTS, AND EXPLORERS

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PARTICIPANTS:

Moderator:

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The Brookings Institution

Panelists:

GENERAL CHARLES BOLDEN
Administrator
National Aeronautics and Space Administration

DEAN KAMEN
Founder
FIRST (For Inspiration and Recognition of Science and Technology)

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P R O C E E D I N G S

GENERAL ALLEN: Ladies and gentlemen, it's a great pleasure to welcome you this morning to Brookings. My name is John Allen and I'm the co-director of the Center for 21st Century Security and Intelligence. And with my fellow co-director, Dr. Michael O'Hanlon, we welcome you very warmly this morning to the Institution.

It's been acknowledged that the underlying base for long-term American national power and prosperity requires an education system where young individuals can excel in science and technology and engineering and Math. Something called STEM. As noted by scholars here at Brookings in the Metropolitan Policy Program, STEM intensive industries produce about 2.7 trillion in added value to our economy, and it's about 17 percent of our GDP. And it's a principle driver in patenting, productivity, growth, and exports. From aerospace to renewables STEM disciplines will only increase in relevance during the 21st century. And given the reality of increasing global connectivity, complexity, and economic competitiveness, the promotion of STEM related skills and knowledge must be recognized as a national priority, a key point we'll make with you this morning, an influential group in the policy arena.

The current state of STEM education in the U.S. clearly underscores the urgency of this issue. According to the U.S. Department of Education the United States is falling behind internationally, ranking 29th in math and 22nd in science among industrialized nations. Additionally only 16 percent of American high school seniors are proficient in math and interested in pursuing STEM related careers. If we wish to preserve the United States as a focal point of innovation and technological achievement, such trends must be reversed and reversed quickly. The necessity for increased collaboration between leaders in the public and the private sectors in developing innovative initiatives for America's future inventors, technologists, and explorers has never been more apparent.

The aim of today's event are several fold, to examine how educators and policy makers can better promote STEM in the nation's future workforce, and to gain a better understanding of how and where such programs should be implemented. Also, where currently and what currently is being done to improve K-12 STEM education, and are there effective initiatives in place to ensure that those who graduate with degrees in STEM are equipped with the appropriate technical and employment skills necessary to lead successful careers.

And we're very pleased and honored to have with us this morning two distinguished guests to help us to understand these issues and to provide us important insights, the Honorable Charles Bolden and Dean Kamen.

Now, what I propose to do is I'll give a brief intro to their bios, and you'll understand immediately why they are key to this future for the United States, they'll provide us some introductory remarks, and then we'll have a guided discussion from the dais up here and then go to Q & A from the audience. I'll remind everyone that we're on the record this morning and we welcome CSPAN to record this event. And also let me know go into the bios of our key participants this morning.

NASA Administrator Charles Bolden, also major general United States Marine Corps retired, was nominated by President Obama and confirmed by the U.S. Senate as the 12th Administrator of the National Aeronautics and Space Administration, and he began his duties on July 17, 2009. Administrator Bolden leads a nationwide NASA team to advance missions and goals of the U.S. space program. As NASA's administrator, Administrator Bolden has overseen safe transition from 30 years of space shuttle missions to a new era of exploration focused on full utilization of the international space station and space and aeronautics technology development. He has led the Agency in developing a space launch system rocket and the Orion spacecraft, which will carry astronauts into deep space destinations, to include perhaps an asteroid, but also support the Mars Mission. He's established a new space technology mission directorate to develop cutting edge technologies for missions of tomorrow. General Bolden's 34 year career in the Marine Corps also included 14 years as a member of NASA's Astronaut Office. And after joining that Office in 1980 he would travel into orbit four times, commanding two space shuttle missions and piloting two others. And his flights included the deployment of the Hubble Space Telescope, and also the first joint Russian-U.S. shuttle mission, which included a cosmonaut as a member of his crew.

Dean Kamen, the founder of FIRST, or For Inspiration and Recognition of Science and Technology. Dean Kamen is an inventor, inventor and entrepreneur, and a tireless advocate for science and technology. His roles as an inventor and an advocate are intertwined with his passion for technology and his practical uses. It's driven by his personal determination to spread the word about technology's virtues and by so doing to change the culture of the United States. As an inventor he holds more than

440 U.S. and foreign patents, many of them for innovative medical devices that have expanded the frontiers of healthcare worldwide. While still a college undergraduate he invented the first wearable infusion pump which rapidly gained acceptance from such diverse medical specialties as chemotherapy, neonatology, and endocrinology. In 1976 he founded his first medical device company, Auto-Syringe, Inc., to manufacture and market the pumps. He later founded Deka Research and Development Corporation to develop internally generated inventions, as well as to provide research and development for major corporate clients. In addition to Deka one of Kamen's proudest accomplishment is the founding of FIRST, an organization dedicated to motivating the next generation to understand, use, and enjoy -- enjoy science and technology.

Let me also acknowledge that we've had a group of young scholars with us throughout the year who are Federal Executive Fellows. Many of them are in class this morning, but I believe we have one who is joining us this morning as well. A Federal Executive Fellow who is bringing his tour to an end. It is a young Marine Corps recently promoted Colonel by the name of Shea Bolden. So we're in the presence this morning of not just two great Marines, but two great Marine fighter pilots. And it is a great honor for us to be in their presence this morning as well.

GENERAL BOLDEN: His mother loves it. (Laughter)

GENERAL ALLEN: I'll also mention -- and this is for my Brookings employers -- I never miss the opportunity to do preparations for a session like this. I was on an airplane flying to the Balkans at the end of last week on a Turkish Airlines flight and I looked up on the television and there was Neil DeGrasse Tyson interviewing Administrator Bolden about the Mars Mission and the nature of the technology that NASA has brought to us every single day. And the session concluded with Neil asking when NASA will produce a flying car, as I recall. So I never miss the opportunity to prepare for these sessions. And initially I thought it was amazing that you had learned to speak Turkish, but then I realized I was on the wrong channel (laughter) and quickly shifted my technological approach to the English channel only to learn it was a great session as well.

So again, this morning we'll have opening remarks and I'll invite Dean Kamen to make his first presentation and to show us a video I believe.

MR. KAMEN: So I figured it would take me way longer to explain first than an efficiently

done video which shows the background and it's told to you by god, Morgan Freeman, who like a lot of people in Hollywood and the world of super athletes that I've gotten behind FIRST, agree he would help us. I said, Morgan, you know what, you could read the phone book and people would pay attention. So put together some short introduction that really captures what FIRST is. Now he did this four or five years ago so the data he has is very, very weak compared to where we are now, because we have phenomenal growth every year. This year, for instance, we had 46,000 schools from 83 countries. But what you need to understand is, you know, I'm an inventor and what do inventors do, we look at the same problems as everybody else and see them differently. And 25 years ago when it was still urgent, when we were 29th in math and 22nd in science even back then -- in the industrialized world -- which puts us at the bottom, let's be clear, we were in Washington and everywhere, always talking about there's a crisis in education. Look at the problem differently. I said no, it's not a crisis in education. Even in those years as today we spend more per capita on education per student in the United States than anywhere else in the world, we have great schools, we have great universities, Stanford and MIT and WPI. So what's the problem? The problem is a very, very, very small group of kids care about that. It's not an education problem, it's a cultural problem. In a free country like America you get the best of what you celebrate and we celebrate to obsession two things, the world of sports and the world of entertainment.

And so 25 years ago I said well there's a system that inspires kids to spend their time and their energy becoming expert at something that really matters to them, but probably not wisely for their career. But let's use that model. But instead of teaching them how to bounce a ball let's give them the skill sets to create careers, to create industries, to make sure this country stays where it needs to be. And if we celebrate science and tech the same way we do these other things, particularly for women and minorities that just are not even present in science and tech back then. So I called on industry to help me and I said the business of America is business. You can't blame the schools; you can't blame the gym teacher if kids aren't going to be good at cricket. And if you put cricket in the curriculum and they do it for 45 minutes Thursday morning before phonics once a week, they're not going to become super because they're going to spend 3 hours every day after school during this season playing basketball, during this season playing football, and they'll do it nights, they'll do it weekends, mom and dad will show up and we have great athletes, but not great cricket players. That's not a Department of Education problem.

So I need superstars. I need the Lebron James of science and tech. They exist in our big companies. In year one of this competition I had 23 of these companies, this year I had 3700 corporate sponsors. But, by the way, this is not an ad. Where do you find superstars of tech that kids even in our culture -- you find them in NASA, astronauts. So from year two on, not year one, but by year two when we went from 23 teams for 46 teams, we had a NASA team; then by year three, more NASA teams. And as of last year the largest single source of FIRST teams around the country was NASA. And we're very proud of FIRST's association with NASA and what they've done for us.

But to prove to you that it's impactful on all kids I'm going to show you the two minute and 54 second introduction to FIRST. His data is now five years old, its way bigger, but listen to god. Can we do that?

(Video playing)

MR. FREEMAN: This is the Super Bowl. The Super Bowl of smarts. It's a life changing competition. Its kids having fun, competing, working together to dream up, design, and build robots.

SPEAKER: It's just an exhilarating feeling. It's like I'm using power tools.

MR. FREEMAN: They're having the hardest fun they'll ever have and they're becoming our next generation of engineers and innovators. FIRST, For Inspiration and Recognition of Science and Technology. My teachers were some of the greatest influences on my life. By challenging and trusting me these mentors got me to understand that I could do anything I put my mind to. FIRST mentors are changing kids' lives every day. Professional engineers, teachers, parents, teaming up with young people not just to build robots, but to build confidence and self respect.

SPEAKER: I'm around people that I can get along with, that I can talk computer lingo with.

MR. FREEMAN: FIRST was founded by one of our greatest investors, Dean Kamen. Dean saw that kids mostly look up to sports heroes and movie starts.

MR. KAMEN: So we said if we've got a culture now that's obsessed with sports and entertainment, let's inspire these kids to be big thinkers the same way Shaquille O'Neal can inspire them to spend dozens of hours a week bouncing a ball.

MR. FREEMAN: Our president agrees.

PRESIDENT OBAMA: Scientists and engineers ought to stand side by side with athletes and entertainers as role models. And here at the White House we're going to lead by example. We're going to show young people how cool science can be.

MR. FREEMAN: 250,000 kids, age 6-18 compete at all different levels. In two FIRST Lego leagues, the FIRST tech challenge. Then at the high school level, the FIRST robotics competition.

MR. KAMEN: The only difference between this sport and all the others is every kid on our teams can turn pro. There's a job out there for every one of these kids.

MR. FREEMAN: Students who take part in FIRST are 50 percent more likely to go to college and twice as likely to major in science or engineering.

SPEAKER: I definitely know that I want to do engineering.

MR. KAMEN: Once they tasted what the power of knowledge is, that it can be fun and rewarding, they won't go back.

MR. FREEMAN: There is no doubt, FIRST works.

MR. KAMEN: 10 or 15 or 20 years from today some kid in those stands will have cured Alzheimer's or AIDS or cancer or built an engine that doesn't pollute. Look at these kids, they're the future.

SPEAKER: I feel like I can go and do anything I want to do because of this program.

MR. FREEMAN: Someone took the time to guide and inspire me. It changed my life. Take some time, go to USFIRST.org.

(Video ends)

(Applause)

GENERAL ALLEN: Terrific, well done. Let me invite Administrator Bolden for his remarks as well and then we'll go to some Q&A.

GENERAL BOLDEN: First of all, just a big message I want to give you as NASA is on a journey to Mars, so don't want you to miss that this morning, if you hear nothing else. But how do we get there. And a lot of the stuff that Dean talked about is critically important. We need young men and women from all over the place who will help us to do that. If you go to the Johnson Space Center today, not a commercial for FIRST, but you'll find that about half the engineers in our robotics lab there at the

Johnson Space Center were participants in the first program when they were in high school. So there is great benefit from it.

You know, we're using our missions to try to inspire the youth of today. I tell people NASA has a $19.3 billion budget today. We spend $19.3 billion on STEM education because every single thing we do is related to trying to get young people interested in -- and we actually call it "STEAM", and we've extended it to be "STEAMD", and the "A" is for the arts, and hopefully we'll have an opportunity to talk about the value of the arts, and design. Because there is a new community of people called "makers". And these are young men and women who have an incredible bit of ability to visualize and make things. I'm privileged to have a young man -- he doesn't know I'm going to do t his -- but Tom Cohoe is shadowing me today. He's an engineer at the Glenn Research Center up in Cleveland, Ohio, who -- he mesmerized me this morning. He's a graduate of historically black college called Florida A & M University where he majored in architecture. And he said he always wanted to build thing, to make things. So spent time in the Army but never gave up on his desire to build and make things, and today is an architect. LaShonda Holmes is sitting right next to him. She's a White House Fellow, went to Spellman College in Atlanta, Georgia, was trying to figure out how she was going to make it through the college the rest of the time and met a Coast Guard recruiter who talked to her about the Coast Guard. So today she flies helicopters in the Coast Guard, something that you don't see very many people who look like her do. So science and technology, the arts, design, are critically important for our kids today. So that's the one thing I wanted to say there.

We believe that you advance the nation's STEM program and you put yourself in a situation where you're able to compete with any country, anywhere, anytime, anyplace. That's what the President talks about all the time. We have created cooperations, collaborations with many other Federal agencies. We work with the Department of Education on something called 21st Century Communities in Learning. We work with the Department of Agriculture in their 4H program and in other programs trying to promote the kind of things the Department of Agriculture does. Recently to celebrate our partnership my deputy, Dr. Dava Newman and the former Assistant Secretary of Agriculture Harden, actually planted some seeds in the Department of Agriculture garden that had come back from the international space station. And they were seeds that were just like the lettuce had grown, the lettuce that astronauts now

eat on the international space station in preparation for going to Mars.

So youth engagement in STEM at every level is critically important. Our priority lies with women and minorities because they represent a huge portion of our population. If you look at women today they're greater than 50 percent of the population. We believe that you cannot leave that behind and succeed; you cannot leave that portion of the population behind and be better than other people. So really, really, really important.

Let me say one thing about FIRST. I'm going to share with you a letter from a principal who was at a school where recently he had some NASA engineers come out and visit. This was a school in West Virginia and the southern part of West Virginia had never had anything like this. They had some engineers from our IV&V, this Independent Verification and Validation facility in West Virginia, and they came out and visited his kids, and they're a middle school. He says I just want to let you know how much it meant to the children for you to come to our school. Seventy-five percent of the students are on free and reduced lunch. This means that our children have less chance than 80 percent of the students to make it out of high school. The community is riddled with drugs, homelessness, and generational poverty. The children need to see that it's possible to make themselves into someone that counts, someone who can help change the world. The younger students came to me and wondered if you would be back for them. This was after the engineers left, because it was too good to be true and they wanted to know if they were ever going to come back again, would they ever see them again. I told them that I sure hope so. They went away with big smiles. We would love for you to come back next year. Put us on your calendar for April 2017. Thank you so much for your commitment to the children of West Virginia. And that's through a STEM program out of NASA.

STEM is not monolithic. That's the other thing we need to understand. We need people not only with science and technology backgrounds and interest, but we need people who are willing to engage their hearts and mind, people who do understand the arts, the ability to conceive of things. And then designers who can build little things like 3D printers and the like that we're currently using on the international space station. So we believe STEM is critical. We want to talk about it a lot today hopefully. If we can fire some of you up to go and tell people with whom you come in contact that it's just as important to have a young student who's going to be an all star on a FIRST court or somewhere else as it

is to be an all star basketball player, then we will have achieved our goal I think.

GENERAL ALLEN: Terrific. Thank you for those terrific remarks. Let me ask several questions and we'll have a conversation up there and then we'll go to the floor for additional questions.

So we've used the term STEAM, S-T-E-A-M. Could we talk a little bit about each one of those components and are any of them more important than the others, or any of them worthy of more investment given the current situation than the others? And I think we've laid a good groundwork with your opening remarks to lay this out. But this is important I think. Let's get a baseline and a definitional approach to STEM or STEAM for the group this morning and for the continued conversation here at Brookings.

Please.

MR. KAMEN: I think education as we all knew it, although we're all different ages -- that the first and the last, the S and the M, for better or worse they do try to teach in school. We all took a science class every year. It was putting pins in frogs one year, it was -- and we all take math. We learn to count and then we learn, you know, algebra and trigonometry. Some of us learned it, some of us didn't learn it, but it was always there. So S and M are there. I think the reason that those weren't well -- it wasn't a lot of passion around them in kids is because they're out of context. There was nothing that a kid ever did in life for which trigonometry would help them. You don't go to a store and the 10 percent discount is the cosign of -- there's no place they see value. And science, you know, putting pins in frogs wasn't all that relevant, but the T and E in the middle, technology is really cool. Every kid that says I hate science, they love Star Wars. Every kid that says they hate engineering, they're wearing super computers, they're immersed in the results of engineering. So to me what industry has got to bring, what our culture has to bring to the schools is the relevance by which it will be important to kids to do the hard work of learning the science. You know, learning math is not easy; it takes multiple years to learn all of that. But there has to be a purpose. Kids would not bounce a ball every day for an hour a day if there was no NBA. They just wouldn't do it. And to me the average teacher may be very good at doing the science part and the math part the same way that the phys ed teacher can teach them the rules and the skills of football, but they don't inspire them. The word FIRST doesn't have the word education in there. We took the position that it's up to our culture to create the passion and then the willingness to work will

follow. And because there's an NBA kids will learn to bounce a ball. Well, we needed to bring NASA, we needed to bring the relevant people who use and apply technology and engineering into a real environment, a hands on environment, as hands on as any of the sports, so that when they kids show up at school they're going to realize, I want to go learn that math, that without knowing that E = YR, that motor controller just let a lot of smoke out of that circuit board because I forgot to multiply by I squared or -- and it turns out, I think, that for better or worse the schools have focused on science as this abstract thing and math as this really abstract thing. We are bringing to the school relevance, we're showing kids that it's accessible and it's fun and it's every bit as rewarding as any other thing they do, except unlike the NBA that has a few dozen jobs a year, right now there are a few million unfilled career opportunities because kids can't do it.

GENERAL BOLDEN: I would agree. The particular part for us is I started out by saying we're on a journey to Mars, we know where we want to go, we just aren't capable of getting there right now because we don't have the technology, we don't have the complete suite of technologies that are needed. So we need kids to be very conversant and competent in science and math, but that's what allows them to be the dreamers that create the technologies that we know we're missing. We find a lot of things serendipitously. The crew on the international space station, they have to have water to survive, they have to have food to survive. So we're finding necessity is the mother of invention. When we flew the space shuttle we used hydrogen and oxygen in a fuel cell and the byproduct of that, the plentiful byproduct was water. So we didn't worry about getting water to crews. Today on the international space station we don't do that, we use the sun to produce electricity and solar cells. So we've either got to fly water up, which is very costly, or we find another way to produce it. So we take yesterday's coffee, we put it into a water purification system, the technology that has used the science and math that the kids learned to create a water purification system so that the astronauts now recycle everything, whether it's urine, perspiration, it makes no difference. So we reuse everything. We're now growing vegetables. We've grown lettuce they eat. We're growing cherry tomatoes. We're not growing potatoes yet, you know, like Mark Watney did (laughter), but we're on the way. So those are the kinds of things we need to do.

The serendipitous discovery is that the same machine that creates the clean drinking

water for the astronauts on the international space station, well guess what -- about 90 some odd percent of the youth, the infants that die in the world today die from water borne pathogens. If we can take those same machines off the international space station, put them into rural villages and -- I'm going to surprise you here -- not just Africa, South America and other places, put them into the south in the United States where kids are dying because they don't have clean drinking water. That changes the whole world. So that's taking science and math, putting it together into the technology field and getting what the nation needs.

GENERAL ALLEN: Are we satisfied with the way that STEM is being presented to students in the educational institutions around the country? And if we aren't how might we change?

MR. BOLDEN: Programs like FIRST, VEX, which his another program very similar FIRST. Kids need hands on stuff. It's like Dean said -- my son is back there, but he's got three beautiful girls that are my incredible granddaughters, the loves of my life -- I don't have any trouble with where they're going to be on the weekend. Unfortunately they're going to be playing soccer, volleyball, basketball, or something else, because that's what we emphasize. But I want them also to be participating in music or in art. And his baby girl is an artist and she spent all day yesterday, you know, Mother's Day just creating incredible artwork. That's really important. So we need to expose them and the schools need to make sure that there are opportunities for kids to do things like create a robot, create a satellite. Today we use something we call -- well, you can call them micro sets, you can call them small sets, you can call them whatever, but they're about the size of this glass. And a kid in elementary school today can be taught to how to take a cell phone, take it apart, take the memory card, take the camera, and put it into a box that big, we'll take it to the international space station and spit it out. And so they have built a satellite. What kid in elementary or junior high school could ever say that several years ago? So we're beginning to introduce that into the informal curriculum of schools, but I'll take the informal curriculum as long as the schools will allow us to put it there for now.

GENERAL ALLEN: Great. Dean?

MR. KAMEN: Everything he said, I think our schools are there to solve the supply side of the equation. I think what's been missing for at least a generation in this country is the demand side. When I was a kid the demand was created in the culture because -- I'm older than most of the people, but

I remember the news Sputnik went up and all of the sudden America, fat, dumb, and happy -- you know, at the end of World War II we were unrivaled, everything was good, our parents all wanted to come back and make the world a better place, that their kids would never have to deal with the stuff they went through -- and suddenly Sputnik went up and it make America realize maybe we're not just the unrivaled leaders, maybe we have other things to worry about. And I think it energized a generation to really understand the critical importance of science and tech and we're in a race. Americans are very competitive. We're fat, dumb, and happy, having a good time compared to the structured cultures in Germany or Japan. We're very happy to just -- until we're threatened. So I think Sputnik did it and then we won that one. And then we sort of relaxed back, which is why you were stating numbers like you have, because Americans -- it's not what we don't have enough of, supply, we have the great institutions but only a few people take advantage of them. They have parents that say yeah, you can play volleyball all weekend, but you better get an A in math.

Well, as I said, 25 years ago we were in that mode where I don't think most of American kids ever saw the real value, the excitement, the fun of science and tech because we've created role models and superheroes everywhere else. But I think the next version of Sputnik is upon us. China has 4000 FIRST teams, 4000 teams. I came back from a trip to Beijing last year. I was there representing the National Academy of Engineers at a joint meeting with the Chinese Academy, and when I told that to people here they said, Dean, you're a traitor because the China are very regimented, their children do learn science and math. What they're missing is the part that's about creativity, how to make use of it, and the Chinese government knows that, which is why they're -- so you're helping them. I said well, think of it as it's the next Sputnik. If you were worried about competing --

GENERAL ALLEN: Very good point.

MR. KAMEN: -- you know, maybe the fact that we now have a couple of billion kids around this planet that are all going to be competitive, maybe the fact that we highlight that will be another call to action in this country to get real hands on passion, excitement in science and technology into the schools, which again is going to require industry to help, and it's working.

And, by the way, I think FIRST will also turn out to be a tool of international diplomacy, just like the original purpose of the Olympics when it was started in 1894 by business people in

Switzerland. They said let's create a platform where all the young people in the world get together every few years and compete in something in a positive way, running and jumping -- the original athletics of the Olympics. Well, it's been 120 years, I'm not sure it's turned into a love fest as they hoped, but if we now have a single language, mathematics, that is the same everywhere in the world, and we have 86 countries this year competed -- we had more countries competing a couple of weekends ago in St. Louis at our championship -- we had more countries representing their FIRST teams than they had in the winter Olympics. For the first time ever through the connectivity you talked about, getting the world's kids to understand that instead of repeating the self inflicted wounds of their parents and grandparents by which they separate each other with political and cultural issues, what if they could all collectively be on the same team fighting against the same challenges, global warming, water, the environment, education, healthcare, security. We could have a generation of kids worldwide working together, cooperating as they do at FIRST and maybe break the cycle of all these self inflicted wounds and take on the real challenges that the world is going to face with nine billion people. And by the way, every one of those challenges is going to require world class technology.

GENERAL ALLEN: I was on a panel -- just to follow up on your comments, Administrator Bolden, two days ago where I made the comment no post conflict society or developing society could ever achieve its full potential without bringing women fully into the mainstream and fully empowering women within society. How can we incentivize the environment in this developed society to bring women more fully into STEM and to empower them not just to study but to get them into industry?

GENERAL BOLDEN: You tell them we won't survive if you leave half the population behind for one thing. And people sometime understand that. But again I think the best thing is to have concrete examples for them to see. We selected the class of 2013 -- the astronaut class of 2013 has 6800 applicants. We selected 8 out of 6800. Half of them were women, half of them were men. Those four women in that group have already become superstars. They were superstars in their own right before selection, but that's now four more women who can go into any place in the world and talk about how they became astronauts. And they're from all kinds of backgrounds. One spent her last year before becoming an astronaut in the Antarctic working with emperor penguins. Another one was the captain of the U.S. women's rugby team, a major in the U.S. Army, helicopter pilot. Another one, the only Marine

selected, is Nicole Mann, F18 fighter pilot, Iraq, Afghanistan, you name it, and was a soccer player at the Naval Academy. So the good thing about them is because we required it is sports is good, sports is important, but sports is a vehicle that helps to build teamwork which, FIRST, again -- the big thing about FIRST is that it builds teams. A winning team, for example, when we were in St. Louis is actually three teams. You know, you talk about my team won, well my team consists of three teams and since I did better than everybody else I picked two teams to go along with me. So they learned to scout. Remember we talked about you need more than just science and math. Some of them using math are now statisticians. They look at the other teams and say boy, we don't know how to do that. That team, we clobbered them, but they did this incredibly well. They want to win on the field of battle. They don't want to have their opponent have their robots breakdown, so they will go help each other in the pits in between contests. And so, you know, we're incredibly proud to look at the number of schools that now can say they've really been turned around because of something like the first program where it got kids really interested in being technologists or being makers or being artists, because it takes everything.

I'm looking at my press secretary over here and my former press secretary over there, who now works for Bono, and they're both just texting away. We didn't know about texting when I first became the NASA Administrator. I don't know that we had ever heard about it. When you talk about the arts, social media, absolutely critical today. If we're going to communicate with the world we have got to know how to use social media. I've got some engineers and technologists and people who -- like me, I don't do Twitter, I don't do Facebook, and I don't do any of that stuff, but I've got really sharp people who know it and love it and serve to communicate our story to the rest of the world. So when I talk about the arts being absolutely important, it is. If you want to get your story out you've got to be able to present it in a fashion -- Morgan Freeman. Could you think of an anymore powerful way to tell the story of FIRST? That is not an engineer, that's not a mathematician, that's not a scientist that is an artist. But he has chosen to take his ability, his MR. FREEMAN given ability and apply it to help kids understand the critical importance of science and math. And so that's why we believe that STEAMD is really, really, really important.

GENERAL ALLEN: STEAM, noted.

GENERAL BOLDEN: STEAMD.

GENERAL ALLEN: Add another letter.

GENERAL BOLDEN: Add another -- add the D for design. There are a lot of designers out there.

GENERAL ALLEN: Dean, any thoughts on that in terms of incorporation of women or further explanation.

MR. KAMEN: So I'm happy to tell you more than 30 percent on our teams, more than 30 percent are women and minorities. And after 26 years of all of our compound growth that number keeps inching up every year. Now you can say well it ought to be 50 percent. You got there me there, but I'll say look what we're trying to do here. You know what the number of women that get patents on technology is, the percentage of patents that go to women? Its low single digits. How many women are practicing engineers or doing welding or -- it's all single digits. So our 30 some odd percent is pretty good. I'd love to get it up to 50. I think our program has a self selecting extra value to women and minorities because again since -- I believe it's a social issue. I mean that group of people is far more unfortunately distracted from the real world of science and technology than kids that grow up in an environment where mom and dad are doctors and lawyers and engineers. The people who really grow up seeing the culture of this country on ESPN and MTV are at a huge disadvantage. So even though we try to get everybody into FIRST there's a process by which when women and minorities start to see kids having fun in exactly the same kind of sporting environment -- I mean it's always funny to me that people say, Dean, you're really hard on sports. I say I'm not hard on sports; I'm using it as a model for something I've been at for 25 years. What do they say? Plagiarism is the highest form of flattery. And I say to people, I love sports. I have a baseball field in my back yard; I have a basketball court and tennis courts. I love sports and they're good for lots of reasons, but in the end people -- well, Dean, you're hard on -- after all, Dean, they -- and you even said it, you know, sports are really good. They teach kids teamwork. You got me there. Then why is it when they do teamwork in a classroom you call it cheating? (Laughter) So I just think the power of sports you can underestimate it, and so we didn't -- FIRST is not like a sport. FIRST is the ultimate sport. It has everything that every other sport has except it's giving you passion to develop the skill sets that will build your life, your career in this country.

GENERAL ALLEN: So are we satisfied then with where --American industry or

companies and the government -- are we satisfied that sufficient investment in R & D and the systems of education are underway?

GENERAL BOLDEN: Since I'm government I'll say definitely not.

GENERAL ALLEN: Okay. And for this audience of policy makers what advice would we give them or ask them to help us with in terms of how we go about the process of incentivizing industry and government and improving our R & D and efforts here?

GENERAL BOLDEN: Well, NASA has a program we introduced in the 2017 budget for the president that's called New Aviation Horizons. And it is for the first time in I don't know -- decades -- where we're going to start building X-planes. If we get the budget, that's the key part. If we don't get the budget we don't build X-planes. What does that mean when you talk about X-planes? Every kids knows, you know, about the -- well, they don't know about the NACA, nobody knows about the NACA, that's the predecessor of NASA -- but everybody knows about test pilots at Edwards Air Force Base and stuff like that, breaking the sound barrier and all that. Those were experimental airplanes -- the predecessor of the space shuttle was the X15 -- and other experimental vehicles. Young men and women today in colleges and universities around the country, believe it or not, were really excited when they saw the President's budget come out with a significant increase in aeronautics that would enable us to do X-planes again. Because that's what they want to do, they want to design and build new airplanes. They don't want to go to a plant and work on a production line where we're building more and more of the same old thing.

Dean invents. Kids love to go. And I use the term kids because I'm an old man, but people love to go to work for Dean, they love to go work for SpaceX, they love to go work for Jeff Bezos and Blue Origin because they're building and designing and creating things. That's what NASA should be doing. So, no, I'm not satisfied that government is doing our part because historically in this country over the last few decades we have abandoned research and development, we have abandoned technology development, and that's one of the things that we have increasingly tried to put in the NASA budget. We started a space technology mission directorate. Its job is to develop technologies.

We can't get to Mars based on what we have today. Yeah, we can go back to the moon and we will, but we want to get to Mars. And in order to do that we've got to have young people coming out of our schools and colleges who are wanting to design and build new things, new technologies we

need.

GENERAL ALLEN: Dean, any thoughts on that?

MR. KAMEN: Well, you asked whether we're investing enough. I'm not an economist, but I'd say to you it's pretty clear that whatever we're investing it's probably at least as important to make sure how you invest as opposed to how much. Because I know that we spend hundreds, many hundreds of billions of dollars a year on public education. As I said per capita it's well known it's more per student than the rest of the world. Here in Washington it's something like $18 or $19,000 per year per student. And then when you take out the very high percentage that don't go to school or drop out, it's ridiculously high. And then you point out we're number 29 in the -- we're number 22 in math.

So I would say you can never spend enough money on things that really have a good return and you shouldn't waste money on things that don't. But to give you a sense of why I'm concerned about that, think about this for a second -- the entire dollar cost to have a FIRST team -- because you can't monetize the passion of the -- we have 140,000 volunteer technology people as mentors, people that we couldn't pay them -- there's not enough money to pay these technologists -- and they all work for free and a lot of stuff in the kits are free. And I always thought getting industry to donate all these most valuable things they have, the time and expertise of their astronauts would be the hardest part. It turns out that industry knows it's a great investment to turn these kids on. It turns out we got to tens of thousands of schools and we didn't run out of volunteers. Here's the staggering thing, with the hundreds of billions of dollars we spend on education almost all of it over the decades or centuries now is locked into fixed costs that can't be changed. Teachers have no discretionary budget, schools develop and somehow they have enough dollars for the parquet floors for basketball and they have enough dollars for the football fields, and they have enough dollars to pay the stipend to the teacher that stays after school to become the football coach or the basketball coach. And that makes complete sense to me. Teachers don't make a lot of money. Engineers can donate their time. The teacher that's going to be there for three hours every day after school ought to get some financial recognition. In 25 years we have had almost no luck getting the school half of the equation to step up even though all this stuff is coming in essentially for free. In fact, it's astounding to me that for less than the cost of one half of one student a whole school can have a FIRST team, but it's almost impossible to get them to recognize the math

teacher or the science teacher with the same stipend for coaching our team because historically it wasn't there. And I think it's an intellectual slap in the face as well as it limits things.

In that regard, a number of years ago I went to our senators in our little state where FIRST got started, one's a republican and one's a democrat and I said I know that year after year they keep trying to do this education bill that -- whatever it is you guys will know -- they finally passed it last year and in it they -- I always forget which is authorized and which is appropriated -- but they did the part which allowed -- in fact it required in the new bill, the new law now, that schools that meet certain criteria can fund, the Feds can fund just the part -- I don't want them to take industry -- but they'll give the teacher the same recognition, the same little stipend, they'll handle the appropriate public school portion of creating our sport and putting it on the same plane as any other sport. So if all of you policy people can figure out now it has to go to the other, which I guess is appropriate has to come next, you guys ought to figure out how to make sure that every school in this country can support a FIRST team. And I don't understand how you could let an institution of learning spend its money on all these other things and not give kids this -- every kid in this country deserves the opportunity to try this. And the policy people in this country ought to realize it would be the best leverage of your resources to let that happen. The entire FIRST organization has 100 and some odd people that now are working full time at this 501(c)(3) not for profit, 100 and some odd people. And we have well over 100,000 volunteers that you couldn't pay to put in a classroom, world class scientists and engineers, which says that for every person working at FIRST there 1000 volunteering working for free. Now just get the schools to bring them in and you'll transform your schools. And if you don't do that this country is going to deserve what it gets.

GENERAL ALLEN: Really important point. And just a point of clarification, I would seldom which to criticize something that Administrator Bolden would say, but I would have to take issue with you calling yourself an old man. You happen to be in the prime of life, from one general looking at another general. (Laughter)

There are a lot of bright faces on that video. Young women and men who were so excited about the learning experience and the competition. How do we get them into the kids of jobs that will leverage that talent that can secure America's future?

MR. KAMEN: Well, the jobs are there. That's the problem.

GENERAL ALLEN: How do we get them into them?

RM. KAMEN: That's the easy part. These kids leave this FIRST program and the world is their oyster. The schools are fighting over them. We had what we called scholarship row. We had 180 some odd universities lined up two weeks ago under -- their scouting just like the football coaches do. And by the way, we handed out over $30 million in scholarships from a lot of little tech schools, some little local trade schools like MIT, Stanford, CalTech, Virginia Tech, Georgia Tech (laughter). They're all lined up, WPI, RPI, they're all there, Yale, and they're fighting over these kids. And these kids get an education in tech and there's no question of how do you get them into the jobs, the question is every company out there is fighting as to they all want them.

GENERAL ALLEN: That's a happy dilemma.

GENERAL BOLDEN: I mean encourage them through whatever means possible to invest their time and energy into STEM related courses while they're going -- not -- and you can't do once they get to college. You've got to have it at the elementary level, then it feeds into the secondary level, and then into college. And it makes no difference -- again I always tell young men and women that I talk to you, you cannot beat having a technical background, a technical degree, because that gives you the flexibility of becoming a poet, to become an author, anything you want to do, the world is your oyster. If you decide halfway through college that you want to be an engineer and you haven't taken trigonometry or basic math, you're out of luck. So there is no downside to getting them into technical courses, into math and sciences. They go through high school and college, it's all up. They can go back. Some of the best teachers come from programs like Teach for America. And they are young men and women who just don't know what they want to do in life, and so they take two years after they graduate from college. Those with technical backgrounds -- you know, Dean talked about having a physics -- you talked about having a physics teacher who didn't know physics. Well, young men and women in Teach for America, they know physics and they know math and everything else. And it gives them an opportunity to take that trade that sooner or later is going to allow them to be an engineer, but to teach young kids in our schools. And they do incredibly well.

So whatever you do, encourage a young person. And young is a relative term, okay. I use the term too loosely. Encourage a person who has never experienced science and engineering. And

the other thing is you have to help kids understand engineers are not only the person in the front of the train. And that may sound trivial to some of you. Coming from my community, coming from the African American community here in the United States, you say engineer and the vast majority of kids think you're talking about the guy in the front of the train. That is not an engineer that we're looking for. We're looking for someone who can look at a system and who can help to integrate things.

So I had a young member of the society of black engineers who I was talking about inspiring people when I first became the NASA Administrator because I said the president told me he wants to inspire, inspire, inspire, and it was a young man who was the president of a chapter of the Society of Black Engineers, he said if you say inspire one more time I'm going to puke. (Laughter) And I went, I beg your pardon. He said I know what you're talking about, he said, but you cannot inspire anyone until you expose them. And so that is the key. We've got to take them by the hand, take them in, and let them see that science and engineering and technology not only is fun, but it's available to them. That there is an incredible demand for them, much more demand than it is, like Dean said, for somebody who can dribble a basketball. You're battling against the odds trying to become the next Lebron James. To become the next Dean Kamen, get your degree and go out and invent stuff. Nobody can take that from you. Nobody can take that from you. And you're probably going to be better than anybody else around because you're passionate about it.

MR. KAMEN: Now you know why we love having NASA as one of our great sponsors. By the way, humility is one of his weaknesses. (Laughter) But at our championship, where we filled an 80,000 seat arena, and that around town we needed to fill the rest of St. Louis -- it looked like Olympic Village -- but once a year we recognize an organization or an individual for helping to bring FIRST to every school in the country and around the world, and it's been given out 24 times. Only one organization has ever gotten it twice, once about 22 years ago and once a couple of weeks ago, and NASA has demonstrated that they've earned it year after year. Again, as a matter of policy you should go home and ask yourselves how can any school in this country, in the 21st century, not be doing everything possible to give kids a passion for science, technology, and engineering. And we found the simplest, easiest, most cost effective, fun way to do it that's consistent with our culture. We're not going to become rigid and regimented, we're not going to be beating on kids to spend 10 hour days in school 6 days week, no

summer vacation. We still have this -- you know, kids have to go home and need the summer off because they have to work in the fields or whatever it was. (Laughter) But this country, its biggest strength is the passion that freedom gives kids. The trouble is their passion is being misdirected to things that will not give them careers. And we've solved that problem for you, but it's so antithetical to the process inside education and technology moves so quickly, I don't think we can expect -- and therefore we can't blame the schools for not making these changes -- but we've brought 20 -- now 3700 tech giants, including people like NASA, saying we're here to help. We'd love to work in cooperation with the schools. We call our competition "cooperatitions". It's all working, but we need to get the schools to do the little bit to just open the spigot and make this part of their culture. Every school should have a football team, every school should have a basketball team, every school should have a FIRST team. And whatever you need to do to make that happen, that's your homework assignment.

GENERAL ALLEN: That's terrific. Let's go to the floor for some questions. We'll go for about a half hour. I want to call it directly at 11:30. You'll be handed a microphone I believe and when you get that microphone I would ask you to please stand so we can see who you are, tell us your name and your affiliation, and then try to keep your question short.

So, sir, please.

MR. COOPER: Good morning. My name is Rich Cooper with Catalyst Partners, former member of the NASA team for a number of years and proud uncle to a young man who was in St. Louis a couple of weeks ago. And he already was on a glide path for great things and he's even more inspired, so thank you for that.

Administrator Bolden, I had the pleasure of being part of the NASA team and working with your education program for a number of years. And one of the things that NASA was doing was creating the educator astronaut that would better help connect students to the program as well as teachers to the program. I'm curious as to where that's going. I know that they're part of the core and where they will be in trying to communicate all of these great experiences.

GENERAL BOLDEN: We felt that the best way to get educators as astronauts is not single them out. So there are no educator astronauts anymore, they're just astronauts. But what we did was there are criteria to be an astronaut. It used to be you had to have a technical undergraduate

background. A person who is a teacher, who has taught in technical courses, math, science and the like, is academically eligible to apply as an astronaut. So we have people like Ricky Arnold, Joel Acaba, they've all flown already. They are not teacher astronauts; they are astronauts who happen to be school teachers. Ricky Arnold is from right out here in Maryland and I tried to get him to come back here but he still wants to fly some more. So we are integrating teachers into the -- they're competitive as astronaut applicants now.

GENERAL ALLEN: This gentleman right in the front row, please. And I'll work my way back.

MR. SCHLAIFER: I'm Allen Schlaifer; I'm the chairman of the Wharton DC Innovation Summit. You've been focusing on people ages 6 to 18, but there is a massive number of people who are undertrained, who are out of jobs, looking for jobs, from 18 on up, including those in college. What can we do to capitalize and to retrain and retain these people in the workforce for as valuable members of society?

GENERAL BOLDEN: Over the last couple of years in our education program we have now begun to integrate community colleges into our area of focus. We didn't do that before. We were looking for college graduates. Today because, you know, a person turning a lathe or a person working in a laboratory doesn't need at Ph.D. or doesn't even need a Bachelor's Degree in many cases, but we do need for them to be trained as a technician or whatever it is. So we focus on young men and women in community colleges today. We really go after veterans, taking them, understanding what their training was for the military, which is directly transferrable -- let me tell you, a rifleman today is a technician. I don't know the last time you looked at a weapon, it's a computer. Looking through a scope you're doing math in your head. Some of it's done for you by the weapon. An artillery man, a person, a forward observer is math, math, math, math, math. And so you take what the veteran has learned because it's directly transferrable into the work place.

So those are things we're doing. We're trying to help retrain people into the fields that we need to get us to Mars. And I think Dean is probably doing the same thing.

MR. KAMEN: And the good news is when you look at all the volunteers you almost need to be at a FIRST even to feel it. It's a love fest of technology. And a lot of the people there are certainly

not 6 to 18 and there are some world class senior -- you talk to somebody, what do you do when you're not -- oh, I'm the chief technology officer at X or Y or Z, you know, something like at Google or -- wow, that's pretty neat. But then you'll talk to some other people, well I just got out of the military and I was a this and I wanted to do that. And it's a great place to network here because you've got 3700 companies. So I think there's a process going on that's just blending all of these people together.

There was a time when education was the skill set you learned and it worked for a lifetime. I mean it just did. An artisan learned something. Today there's no skill set you have today, especially in the technology field, that's going to be worth a damn in three or four or five years. We went from telegraph to telephone and that was a generation or two, but we went from the internet to email to texting to Snapchat. You know, the lifetime of some of these technologies is six months. Education is not a destination, it's a process. In the world of technology you're either going to learn how to learn or you're toast. And a kid coming out of school with a technical degree I hope these days understands that what their education gave them was the ability to keep adapting to future technologies because they don't have a skill set that's not going to be obsolete very, very soon.

GENERAL ALLEN: Dean, if the audience members wanted to attend a FIRST even how would they find that out?

MR. KAMEN: So we to have only one event at the end of the season. I'd give everybody my FIRST card and say come on to this high school gym. After five years of growing we outgrew any venue in New Hampshire and we got Disney to put us on stage. Fly down. If you use the sports model, the most expensive -- kids can watch the Super Bowl on TV and then they can get -- they can watch the World Series, but unless there's little league in town, unless there is t-ball where they hold the ball still, those kids can get into baseball before they can run, unless you can make it local you can't get them. As you said, you've got to start early. So we started doing regional events. By the 10th year of FIRST we had 1 regional every weekend in March around March madness before the championships that happened in Atlanta at the Georgia Dome. Well, we keep building up more and more regionals to be more accessible because the most expensive part of FIRST would have been airplanes and hotels for kids to play.

So this is the card I give out now, this season, which each weekend in March -- we had

126 cities hold their regionals. You know, little cities, New York, Detroit, Chicago, Los Angeles, San Jose, Cleveland, Seattle, Houston, Orlando. So we had 126 events. I can guarantee nobody in this room is out of driving distance to one of our March madness events.

GENERAL BOLDEN: If you looked, the convention center was full one week in I think it was March or late February, and that was several regionals. So they are everywhere.

MR. KAMEN: I have regionals in downtown Washington.

GENERAL ALLEN: So this March madness really is madness when it's all said and done?

MR. KAMEN: It's madness.

GENERAL ALLEN: There's a lady all the way in the back. May we hand her the microphone please.

MS. ORAVEC: Thank you very much. I'm Jo Ann Oravec from the University of Wisconsin and I've got a question about the time span of some of the projects you're talking about. For example, the Mars project. We're dealing with an age in which students have relatively short attention spans according to research and all of that, and perhaps a Mars fatigue could be setting in. But also some of the other interesting projects. Dr. Mae Jemison, as you know, has pioneered the 100 YSS project in which the stars are the object and 100 years is the goal. And of course there are public forums and a lot of research being done as to how to get there. Now how can we stimulate people to keep going toward that very lengthy goal?

Thank you so much.

GENERAL BOLDEN: You're absolutely right. You know, we're going to Mars in the 2030s; that's a long time from now. Unless you happen to be in the program, and that says we don't have enough time to get ready. That's 14 years from now. So we're talking about humans in the Martian environment in the 2030s. And we're going to do that, but there are all kinds of precursors. How many of you saw the movie The Martian? Anybody read the book? Those of you who read the book -- and I didn't finish it -- but those of you who read the book know that Mr. Weir in his book he gives you what NASA has been doing for the last 40-50 years. It's called precursors. So every time you turn around we're sending another satellite. It's either going to be an orbiter or it's going to be a lander. Curiosity, we

landed three years ago, 2020 we're going to launch another Curiosity size rover. This one is going to collect samples from the Martian soil and then we've got to figure out how to get it and bring it back to earth. There are other planets in the solar system. When we sent New Horizons to Pluto back in July -- the year just keeps going (laughter) -- but, you know, it was a long journey, nine years to get there. Things that we want to do now is increase the speed of transit. So I need young men and women who are interested in propulsion, who want to give me another way to get to -- Mars is eight months today, that's too long. It's too long for a number of reasons. For the human body that's much more exposure to radiation and the like. So things that are happening now is what we're trying to do, bring young people in who can work on something that will see a return in the next 2 years as opposed to 14 years. And there is all kinds of stuff going on.

Aeronautics, that's the reason we want to build X-planes. Because a student in a university can start working on an X-plane. They can actually see the X-plane fly. If they start as a freshman they're going to see the X-plane fly before they get out of school. If they're a maker, if they're work on small sets or cube sets, they can build a cube set in a matter of six months. And the way that we respond today, we can fly their cube sets as what we call a hosted payload. So we just stick it on a satellite that's going to space anyway, get it up there, throw it out, and for a week or two these kids, you know, they have their own control center in their school and they can sit there and watch their satellite as it either brings an image to earth or it pipes down a preplanned message that says hello, I'm here, I'm the cube set from St. Mary's High School, or something like that.

GENERAL ALLEN: Terrific. Halfway back on the aisle. Sir?

MR. WORKMAN: Hi, I'm John Workman with the American Association of Geographers. We've had a huge growth in our organization's membership in recent years because of GIS technology. And we're currently working in the K-12 field to try to get the College Board to adopt an AP GIS course which we think would --

MR. KAMEN: Do you want to tell everybody what GIS is?

MR. WORKMAN: Yes, it's geographic information systems. It's a precursor to GPS.

MR. KAMEN: I hate acronyms.

MR. WORKMAN: So we've been trying to get this course adopted so that kids will think

about GIS at the K-12 age, which they currently only do at the college age. Last year Congress passed and the president signed ESSA, the new K-12 law for the country, the Every Student Succeeds Act. One big challenge I see in it is that it basically returns most Federal education dollars directly to state control.

So I guess the question is how do we get the states as individual entities to think about STEM or STEAMD education and really focus on it without a Federal priority for it?

MR. KAMEN: Well, I see there's a guy, Mr. Berger. Stand up a second. So I --

GENERAL ALLEN: Hand him the microphone please since we're going to --

MR. BERGER: That's really a terrific question. Although we support return the funding decisions to the state and the localities, it's not just the state. I mean that's the thing about FIRST, is it's ground up. We have a terrific set of regional directors, one for each state. Some states we have three, like California. And they work with the local education agencies to promote STEM, to promote the FIRST concept, as Dean says, to bring it into their school with the funding. You need to work with organizations that have a local footprint, and many of the organizations in the education arena do. That is at least my opinion on it.

GENERAL BOLDEN: If you're from a state, and every state, every county has 4H, one of the reasons that NASA has taken to collaborating with the Department of Agriculture and 4H is because we have 50 what we call education land grant. It's in the land grant college in each state where there's the NASA Space Grant Consortium. That's 50 of them around the country. 4H is in hundreds of counties. They're in every single county in the country. So NASA now teams with 4H. We provide the content, we provide information on science, engineering, you name it, and it gets out to every county in the country. So that's one way to get at -- whoever asked the question about how do you get the schools to use the funds for science and engineering and the like. So we partnered as I mentioned earlier with the Department of Education on 21st Century Communities and Learning. It's the same thing trying to work with the states to get them to understand the absolute value of STEM education and the fact that they've got to take this money and reinvest it in giving their kids an opportunity to get into STEM education fields.

But it's really up to you all to not let the states and the counties and the municipalities that control the schools, don't let them off the hook. Because if you do, it will end up being somebody's

football stadium.

GENERAL ALLEN: The gentleman all the way in the back against the back wall.

MR. STEVENSON-PEREZ: Thanks, Rich. I have a question about the big concept staring at all of us --

GENERAL ALLEN: Please identify yourself, sir.

MR. STEVENSON-PEREZ: My name is Henry Stevenson-Perez; I'm a Federal physician. I specialize in helping people at an individual level grasp the concept that's staring us in the face -- intelligence. I'm a cancer doctor and we're changing the way we're thinking about cancer. For 100 years we were focusing on the cancer cells and now we're focusing on the intelligence of the surrounding environment. And that's the only word we can use, intelligence. But as scientists we don't have a word for that really.

And so my question is simply this, if you think about how scientists or thoughtful people might think about the concept of intelligence in 1916 when Brookings was started, at the dawn of the industrial revolution, or 100 years before that when we were solidly in the agricultural economy. We would have certainly come up with different definitions for what we thought intelligence was in 1816 versus 1916. Here we are 2016 and I'm wondering if this is a good time just to think thoughtfully about what is intelligence in the 21st century as we start to retool the whole thing.

Thanks for your patience.

GENERAL ALLEN: Terrific question.

MR. KAMEN: Well, I think what you said was some of the most fundamental presumptions that we've made throughout time. You only went back to 1816, you need to go back 1000 years before that. You can go back just a few hundred years before that, it's called the Dark Ages. And nobody in their own time ever realizes they're -- I mean I doubt some monk during the Dark Ages said to a monk, I got a great idea, and got whacked in the head. You can't have a great idea; don't you know this is the Dark Ages? (Laughter) I mean I think today cancer, as an example -- my brother is an M.D., Ph.D. oncologist, would say it isn't the cells. We shouldn't be treating the disease; we should be treating the patient. And by the way, it's the immune system, it's not the cell. The cell is the symptom. And yeah, it took 100 years to get there and now we're starting to get somewhere. But all you said I think was the

fundamental perception of what we know and how we know what we know, and how we're going to use that to move forward, is more critical than ever because the world is moving faster than ever. And frankly all those other jobs that you could have if you weren't so cerebral, you could make a living as a farmer, you could make -- in your 1816, you could make a living in a production line in 1916. Today there's nothing left that -- if it can be done by menial labor it's being done a machine or a computer or a robot.

So what I think you said was going forward intelligence and how to add real value to solving real problems is going to be the only way humans can succeed and move forward, because all the rest of that stuff is going to look like the Dark Ages. Which brings me back to saying why don't we all collectively make sure that kids have the most valuable tool they can possibly have, a broad based education, particularly with analytics and mathematics.

GENERAL BOLDEN: Can I go back to one quick thing -- and I apologize because I didn't think I had an answer. But we talked about demand. There is no shortage of supply. The big question today is demand. We have no facilitated the potential success of a commercial space industry. Why do I say "potential success" of a commercial space industry? We now have more rockets and rocket companies than you can shake a stick at here in the U.S. So we have returned the ability to launch to U.S. shores. SpaceX, Orbital Sciences or Orbital ATK, ULA, you name it. What are we lacking? A demand, a place for those things to go and for all these astronauts that people claim they were going to open up the world for with commercial space, because everybody wants to go to the international space station. We need more platforms and low earth orbit. On the international space station we work with the NIH. Dean mentioned the human immune system. We don't understand it. It goes through changes when you go into the microgravity environment of space. We have learned a lot over the 30-40 years humans have been flying. We don't fully understand it.

We just finished the first ever study in genomics, human genomics, with the twin study, Mark and Scott Kelly. Scott Kelly on orbit for a year, Mark back here. Identical twins. We will get more new knowledge from the twin study than people ever thought as imaginable. We have the ability to do this as a nation in an international space community, but we've got to respond, we've got to provide the demand, we've got to put more platforms out there. If you want to be a pharmaceutical developer put a platform up in space where you can send the seeds for those pharmaceuticals without astronauts.

Astronauts are horrible when you start -- when you want to do micro processing and materials processing and pharmaceutical development because we've got to exercise. And every time we get on a treadmill or on a bicycle or something, you don't know it but the vehicle starts to shake. That just drives a material processor berserk because now you're taking the quiescence of microgravity, of being in space and having no gravity affect your project and having no G and all this stuff, and you're introducing a doggone astronaut who's got to exercise. And so now you're shaking your stuff. (Laughter)

Take a platform, a small platform away from the international space station, put your pharmaceutical development there, put your materials processing there, you're going to get pure semiconductors, you're going to get great drugs, you're going to get all kinds of stuff. That's the demand that we don't have yet because everybody is sitting back relying on NASA to provide the international space station. That is not a demand for a commercial space industry. And I've been saying that for seven years now. We have got to create the demand for this supply that we are developing.

GENERAL ALLEN: Thank you for that question. About two-thirds of the way back, the lady with her right hand up. And I'll promise to come to the other side of the aisle here in just a moment. Go ahead.

MS. LEWIS: Thank you. My name is Autumn Lewis and I'm with the National Council on Teacher Quality. And something that we haven't talked about today is the shortage of STEM educators that we're facing across the country. So what are your suggestions for how states and districts can incentivize talented individuals not only to pursue STEM degrees, but to go back into the classroom and train the next generation of teachers?

MR. KAMEN: Quit telling girls they can't learn math and science.

GENERAL ALLEN: That's a great question; really good question.

MR. KAMEN: I'll go with that. I'll also say let's be realistic. While industry now with its shortages is willing to pay unbelievable premiums for kids that -- engineering, the fact is the marketplace is saying if you have a degree in engineering or mathematics you're opportunity to make two or three or four times as much as teacher can make says that whatever have been the challenges to great people to be teachers, it's even tougher if they're science and technology teachers. I mean my mom was a teacher, and I hate to say this, but I think an unintended consequence of preventing women when my mom was a

young woman from going into business and doing all the other things that women of course should have a right to do, an unintended beneficial consequence is really smart, passionate women went out to teach. They were smart enough to realize the most valuable thing this country has is all its kids. And these incredibly talented women became the teachers. Now these incredibly talented women, especially if they learn it, might go somewhere else.

So as a pragmatic guy I would say to you it would be naive to assume you're going to be able to attract the best of the best of the world of tech and put them in a classroom. I also think they chose to be an engineer, a scientist, they didn't choose to be a teacher. They may not be good at teaching. But I go back to my sports analogy, Lebron James is not a phys ed teacher. That's okay. They couldn't afford to pay him what he is being paid and he wouldn't have as much impact on a whole generation of kids if he was in one classroom. He's there to create demand and then the teachers have the skill sets to teach it. I think what we ought to be doing, and what first I think very well is we've taken 140,000 world class passionate people, many of whom are women that are scientists, engineers, proud of what they do, and let them be the role models, let them work with the schools, let them be -- that's why we call them the mentors not the teachers -- and you get the best of all worlds. You get people to be role models working directly with these kids. You don't have to pay them, you can't buy passion. They want to do it, they do it very effectively, and they bring into the schools the world class capability of professional scientists and engineers to inspire the kids. And then the teachers will have no problem. If the kids are passionate to learn, the teachers will do just fine.

So I think it's naive -- in the same way I said let's redefine the problem as not an education problem but a culture problem, let's not try to define the problem of let's find 100,000 young scientists and engineers that will also suddenly want to become teachers, would be good teachers, and that we can finally pay them. None of those assertions are likely to happen quickly. But instead let's say let's create a partnership between great schools, let them have access to FIRST, and let's get the whole tech community to be there, cheering for these kids and helping to be their role models. That we can do.

GENERAL ALLEN: Okay. We'll do two more questions and then give a little time at the very end for both our guests to summarize very quickly.

Yes, sir, please.

MR. CROWSNEY: Thank you very much for coming here. My name is Jeff Crowsney, I'm with IVA Capital Management. I'm reminded of Sheryl Sandberg and Jeff Bezos favorite book when they were growing up, it was called, “A Wrinkle in Time”. And I'm not sure if you've read “A Wrinkle in Time” lately, but it is a fascinating book which inspires individuals who are at a K level, at a 6th grade level, even at a high school level. I'm just kind of curious if STEM would create, or if you could somehow put that type of passion where you can actually -- when you're reading that type of book, which is again maybe a 250 page book, so it's a quick easy read, where you can inspire that type of passion and creativity through graphic novels, through games?

MR. KAMEN: First I have to tell you Jeff Bezos is pretty cool, but we formed a thing called the mothers of invention at first, and Jeff Bezos has a mother, Jackie, and a father, Mike, who I was on the phone with this morning actually. They came to the championship; they're huge sponsors, their huge supporters. I bet based on what you said we can figure out how to maybe get Amazon to spread that book among all of our constituents and I'll work at doing it. But to your point I think inspiring young kids to see how accessible and how much fun science and technology is, is the simplest and most effective solution to what has been now for more than 25 years the big concern of industry and government in this country, just how much we lag the rest of the world. And again, you can say it over and over and over again, it isn't the schools' problem and they won't be able to fix it. We need to fix it. The business of America has always been business. And if we decide as a culture we're going to promote something, it works. We're not 29th in the world in the Olympics and they're all amateur athletes. This country needs to focus in a real hurry -- you know, we're in a race with catastrophe and I don't want catastrophe to win, but inspiring kids by whatever means it takes is going to be the solution.

GENERAL BOLDEN: Science fairs. I fell in love with science when I was in 7th grade. And I thank two male teachers. One was my 7th grade science teacher who introduced me to a science fair. I never did not do a science fair after that. And you don't have to do a big project was what he told me, just do one. You got to. If you're going to get a grade in my class you're going to do a science fair project. So it was a classroom science fair that then went to the school. The President -- you know, the reason he brings hundreds of kids to Washington, D.C. every year is to try to emphasize the critical importance of allowing a student to participate in something that is available to every single student. And

it doesn't require a lot of money. My first one was getting a solar cell and having it ring a bill whenever I took a flashlight. That's pretty basic. But getting kids into science fairs, you can do that in elementary and junior high school. And you won't catch everybody, but some of them will be hooked.

Math fairs. You could go on, and on, and, on.

GENERAL ALLEN: Ma'am, all the way in the back please. And this will be the last question.

MS. KLEMM: Hi, I'm Rebecca Klemm; I'm often times known as the numbers lady. And I want to talk about adding to coming -- I used to teach university, I taught high school, middle school, and now I also work from the beginning to get young kids interested in invention and building. And I challenge you all, if you're going to ISTY, I'm going to be doing two of the playgrounds, it's called Building NumberOpolis. It can be done from preschool to Ph.D. level where we -- NumberOpolis is where numbers live, all the numbers, plus pie and phi and all of them, and they're building the town. So I start at maker faires, I'm at science fairs. I'm out there and I teach teachers how they can bring activities into their room. They're afraid they won't have time for the tests, but I show them how the kids get so engaged with my patents on puzzles and building. And it's a math teacher and math is now fun, it's not out of a textbook. So I'd love to talk to you about bringing it down even lower, which was the only age I had never done and I love having the parents be busy while the kids are busy so they don't do it for them. So I have things for them of all ages. It's called Building NumberOpolis. I'll be at the Mateo Maker Faire. I do maker faires all over the place and adventure faires and have the kids from young ages create puzzles and create houses that reflect numeric patterns and shapes. They're building unusual polygons.

GENERAL ALLEN: So for the numbers lady, thank you very much for that unpaid commercial. (Laughter) Well done. No, that's very important what you're doing. But let's have one question then, finally, on the left. The gentleman in the back with the blazer. Yes, sir, please.

QUESTIONER: Thank you. Administrator, last November you said that the United States should include the Chinese Human Space Program, but Congress still bans that kind of collaboration. So why do you think it is necessary for the two countries to work on the space program? And do you think in the near future is it possible for the two countries to start working on such kind of a program?

Thank you.

GENERAL BOLDEN: I think what we do today with China as a partner in the areas other than human space flight, it's a matter of law that we can't do bilateral activities with China in human space flight. And I believe it will happen one of these days. That's not something on which I'm presently focused, but we do work with China on an incredible basis in terms of earth science, looking at glacial characterization in the Himalayas, looking at things like earthquakes, what we call geodetics, and even looking at some aspects of lunar science. So you take what you can get and you go. You know, that's the one thing that's different between NASA and say a company. Government is inherently slow. And so one, if you want to work inside the government environment you have to be patient. And am I happy? No. But are we making progress? Yes. And so one of these days no one would have ever dreamed before the Berlin Wall fell that the U.S. and the former Soviet Union would be collaborating in space.

Today, as a matter of fact, as a direct result of the Berlin Wall falling and the Soviet Union falling apart, it was a geopolitical decision, we needed to find somewhere for Soviet, now Russian, scientists and engineers to go so they wouldn't do bad things. What better place to send them than to collaborate with NASA and our international partners and building an international space station? A lot of people think that the international space station started with Russia and the U.S. Russia was the last of the five partners to be brought in and President Clinton directed NASA to integrate Russia, the Russian space agency, into the international space station. Today they are one of our five partners and a key partner. So patience is a virtue. It will happen in time. It won't happen during my tenure as the NASA Administrator because I go with the president, so when the president leaves I leave. But it will happen. Be patient.

GENERAL ALLEN: And in a world where tend to concentrate way too much on confrontation it is with U.S. and China and Russia where we can find a lot of common ground in the area of space and technology.

GENERAL BOLDEN: It's hard to hate people -- and I'll say this as a 34 year Marine -- we deal with a lot of bad people. General Allen will tell you this, my son will tell you this, if you want bad people to become good people you've got to engage them. And if you choose not to I can guarantee you they're going to stay really bad people. A lot of people don't like to hear that, but we spend a lot of time

dealing with people who want to be like us, want what we have, but don't know how to do it, so we try to go out and teach them. That's what General Allen still does today. His wife is wishing that he'd quit (laughter), but it's in his blood.

GENERAL ALLEN: Ladies and gentlemen, there is still a forest of hands every time I ask for questions and I think that indicates how rich this panel has been. Let me just ask each of our two guests if they'd like to make a couple of minutes of summary comments and we'll go from there.

GENERAL BOLDEN: I think I've said enough. I just want you to remember that your space agency is on a journey to Mars. We have lots of thing that we do that aren't just human space flight. We have an incredible science program. We didn't even talk about it and it's in four areas. We look at plants, we look at our own planet earth, we look at the sun, and we look at what we call astrophysics. How did we get here and is there life elsewhere. And STEM education is our number one product. We spend $19.3 billion on it every single year.

GENERAL ALLEN: Dean.

MR. KAMEN: And you heard that we have to engage our enemies, otherwise they'll just become a bigger enemy. Two of the phrases used all the time throughout the FIRST community are gracious professionalism. You heard Charlie Bolden point out that these robots are fiercely competing in their two minute rounds and then in the pits the teams help each other when one of them has a broken axel. And gracious professionalism along with what we call "cooperatition". That all the teams will cooperate as they compete so that we all end up with the best of the best, and it's part of the culture of FIRST. I started by saying this and I'll end by saying this, in a free culture -- and there's no culture freer than America -- it's either your biggest strength or you biggest weakness. Even kids are free in this country. And to have a Bill of Rights, they don't have a bill of responsibilities. We ought to have a bill of responsibilities.

GENERAL ALLEN: That's the next panel.

MR. KAMEN: But in a free culture when you get to do whatever you want it's incumbent to inspire kids in this country to do it because they have a passion for it. And if we're going to recognize that in this country of ours where we get the best of what we celebrate, if we want the best of science technology, global competitiveness, security, we've got to give kids some vehicle, particularly women and

minorities, that is so appealing to them is competing for their hearts and minds with what used to be the national pastimes and distractions that are great as long as they're in the right proportion.

And if you, our policy people, all I can tell you is we have created a model that's scalable. Every major tech company in this country, the schools love it, the parents love it, the teachers -- everybody loves is. But you heard Charlie Bolden point out government moves slowly. And the great irony is nothing is moving faster these days than technology and government and getting teachers that are really good at tech into the classroom is not a likely solution. You can't scale our old model of lines of kids, you need hands on real learning that develops passion. We have the model. You need to figure out how to get government to be a catalyst to make it available to every kid quickly. If you don't, we will all suffer.

GENERAL ALLEN: Ladies and gentlemen, Tom Brokaw not long ago used a term, the greatest generation. That was one of the first times we had heard that term coined. I think he used it in implication for the outcome of World War II and Americans and our partners who had stood on the ramparts and defeated an existential enemy. I would contend though there's a new greatest generation. And General Bolden and I and his son, Jay, have seen them in action. But when you saw the bright faces on that video here this morning, that's the new greatest generation. The greatest generation that will propel this country and our friends and sometimes our opponents who will become our friends to another level of human existence. And this kind of a conversation today is what brings that to fruition.

So let's thank our panel this morning and thank you all for coming. (Applause)

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