CENTER FOR
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NASA AND ACCELERATING AMERICAN INNOVATION

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JOHN HAMRE: Okay, folks. (Chuckles.) You know, if we – if we had to pay him what he's worth, we couldn't afford the billing hour. So I want to get started here. Thank you all for coming. Delighted to have you here, and it's really a great privilege to have General Bolden with us.

First let me tell everybody, you know, if you – if you got a cell phone, put it on "stun," because if it rings I'm going to walk over and haul you out because we don't want the interruptions.

This is a real privilege. On a personal level, I had the privilege of working with General Bolden through a number of years. We served together back at DOD. He was – he was still in uniform at the time serving so ably in the – in the Marine Corps. And then I thought he deserved his private life – and he did too, for a very short time, but then was called back into service by President Obama and to head up NASA.

I think it takes a combat-tested Marine to be the administrator of NASA today. These are – (chuckles) – tough days, you know. We've got – we have expectations that are enormous; we have budgets that are constraining. And we have, you know, foxhole-to-foxhole politics in Washington. This is going to be hard.

But I happen to know General Bolden, and he's absolutely up to this challenge. He has such an embracing personality. You know, he combines what I always have admired in the Marine Corps – you know, a charming personality but willing to fight literally foxhole to foxhole to get his mission accomplished. And it's going to take that this year. It's going to be a tough year.

But because of his spirit and his – and his energy and his courage, I feel fairly confident that we're going to prevail. He has an ambitious technical agenda for NASA coming at a time when the government feels it's broke. And one of the great challenges that he faces, of course, is to reinvigorate that sense of excitement that – those of us that are sitting right here that have grey hair remember that. A lot of the others don't, you know?

But I can still remember those days, how thrilling it was. We just were glued to the television to see John Glenn go in orbit. You know – you're too young. You can't shake your head up and down. You're too young. You can't remember that. (Laughter.) Maybe you saw the movies, you know? (Chuckles.) But we remember that. We remember that thrill. And unfortunately that thrill and excitement isn't with us. So it's a harder story to sell to the American public, that an active space program is still an important national objective. But it is. And that's General Bolden's responsibilities now.

So we're fortunate to have him here. I will tell you, I'm sure he's here to enlist all of you in helping him this year. And we should, because this is what's going to be all of our

responsibility, to try to bring this forward and make sure that, in this turbulent environment, that that prevailing good that we see in NASA and in those programs still is able to survive through a tough year.

And so with that, General Bolden, we look forward to hearing your remarks. Thank you all for coming. Thank you, General Bolden. Thanks for coming. (Applause.)

CHARLES F. BOLDEN, JR.: Thank you. Dr. Hamre, thank you very much. Thanks for the invitation. But most especially, thanks for the very gracious introduction. I do not deserve that.

There is a person I want to acknowledge here, and she is a dear friend and a recent occupant of a room in the astronaut office in Houston. And that's Julie Payette, who is back here in the – in the middle section. So Julie, thanks so much for coming out. I had the privilege of welcoming Julie home – seems like yesterday, but it was probably a year ago. Well, I don't know how long ago.

Two years ago? Was it really? Oh, man. (Laughter.) Well, I guess I'm having too much fun. But I do thank you for coming. And I thank all of you for coming. And I hopefully will have an opportunity to exchange a little bit before they give me the hook and pull me off.

But when President Obama said in his State of the Union address that he wanted our nation to out-innovate, out-educate and out-build the rest of the world, we at NASA knew that – we knew exactly what he wanted. It's the kind of philosophy – sort of what Dr. Hamre talked about in his introduction. It's the kind of philosophy that has always driven our thinking and our missions. It's what got us to the moon. It's why we have the world's most advanced fleet of Earth-observing satellites. It's why so many of our exploration technologies have successfully made the transition from NASA to the private sector and your homes and businesses.

In this fiscal year 2012 budget request for NASA, the president addresses all the elements of our strongly bipartisan authorization act of 2010, which sets us up on a path to create new technologies to win the future. This budget requires us to live within our means so we can invest in that future. It maintains our strong commitment to human spaceflight and new technologies. It establishes the critical priorities and invests in excellent science, aeronautics research and education programs.

At its core, NASA's mission remains fundamentally the same as it's always been. And it responds to our new vision: to reach for new heights and reveal the unknown so that what we do and learn will benefit all humankind. But now, we carry out this mission with a renewed commitment to focusing on what we do best while engaging America's innovators and entrepreneurs as partners in our journey.

What the president is talking about is a renewed commitment to the energies and expertise that we already possess, and a charge to bring them to the next level. And that innovation will help drive our economy through the creation of high-tech jobs and breakthroughs that today we can't even imagine.

America is the nation we are today because of the technological investments made in the past 50 years. Our lives have been greatly improved by directing scarce resources toward exploring space. Knowledge from weather spacecraft, efficiency improvements in both ground and air transportation, biomedical applications such as blood-flow monitoring devices, implantable insulin pumps, pacemakers and LASIK eye surgery, and the protective clothing and air-breathing packs that keep our military, firefighters and police safe are all derived from our nation's investment in exploration.

NASA's space technology makes a difference in our lives every day and can be a spark to an economy that is becoming more technology-based over time. NASA's successes and, yes, even its failures over the past 50 years have inspired countless people to pursue science, technology, engineering and mathematics careers. And the outcome of NASA's endeavors, both in technology advancements and intellectual capital, has transformed our world.

NASA's renewed focus on innovation and technology is vital. By investing in high-payoff disruptive technology that industry cannot tackle today, NASA matures the technology required for its future missions in aeronautics, science and exploration while proving the capabilities and lowering the cost of other government agencies' and commercial space activities.

Consider for a moment how the architectural options for human space exploration of our solar system will change when reliable, commercial access to low Earth orbit, propellant depots, inflatable habitats and advanced in-space propulsion technologies are available.

For our science missions, consider the improvements possible, from new optics, lightweight materials, structures, and power systems and high-bandwidth communications. Consider the efficiency gains in radiation shielding, in closed-loop life-support systems that may become possible from improved human knowledge of human adaptability to the space environment gained through scientific experiments on the International Space Station.

The president's fiscal year 2012 budget funds a diverse array of human spaceflight programs that maximize our use of current capabilities such as the International Space Station, facilitate innovative approaches to ensure U.S. leadership in low Earth orbit and position us to explore the frontiers of deep space.

Taken together, these initiatives will enable America to retain its position as a leader in space exploration for generations to come. To do this, we'll need to transform the way we do business. We'll need to be innovative, creative and agile, adapting to rapid changes in technology and business practices. By transforming the way we do business, we can help ensure that our nation's space program is affordable, sustainable and realistic.

Realistic does not mean less exciting. NASA's chief technologist, Bobby Braun, who is sitting right here on the front row – and you'll get to hear a little bit from him when the panel comes up. He's going to tell you about some of – some of the ideas that we have. What Bobby

does is very exciting; he'll tell you some more about what he has in mind for bringing NASA to the next level of technology readiness to achieve the big things we have in mind.

As we increase our capabilities, we'll apply them to many different types of missions and move on to the next challenge incrementally. We need to get started on a lot of these technologies today. And we will.

Over the next decade, innovative technology investments are required to bring future missions such as exploration of near-Earth objects, the moon, and Mars within our reach. These transformative technologies will reduce the cost and risk of future missions. Similarly, technology needs abound in deep-space exploration, astrophysics, aeronautics and Earth science. In each case, NASA technology investment is critical, for without such an investment, these future missions simply won't occur.

Achieving great things also involves taking informed risk. The space program needs to return to our roots of informed and measured risks. Exploration and innovation have always come with risk. In fact, if we don't understand, accept and even embrace risk, we can't move forward boldly. Landing on Mars will never be a low-risk venture, nor will the development of a telescope capable of detecting Earth-sized planets around other stars, or the flight of a new generation of human-rated space systems.

Our nation needs to dream big. And these are precisely the right missions for NASA to pursue. An informed, risk-taking strategy commensurate with the agency's goals and expectations is not only acceptable, but also required. How else can we accomplish the grand achievements our nation has come to expect of NASA?

At NASA, a goal of the president's innovation strategy is to reposition the aerospace community on the cutting edge, pushing the boundaries of the – of the aerosciences with the technical rigor our nation expects of its space program. Innovation, education and technology development will be essential to America's success in the 21st-century global marketplace.

They will be required for us to reach new destinations in the solar system and are the engines that will create new products and services, new businesses and industries and high-quality sustainable jobs, while improving the capabilities and lowering the cost of other government and commercial activities.

Small businesses have generated 64 percent of net new jobs over the past 15 years, leading the innovation push into the future. NASA's budget calls for increases in the maximum award values to small businesses that propose innovative research and development ideas aligned with NASA's technology needs.

NASA will invest $184 million in research and technology development by small businesses next year, money that will directly fuel the number of jobs that small businesses create in America. NASA also will continue to fund prizes and competitions that seek creative solutions to technical problems in aerospace technology, solutions that can immediately transfer into the commercial marketplace.

As the president recently pointed out, innovation isn't just how we change our labs, it's how we make a living. Nowhere in this – nowhere is this more true than at NASA, where America continues to reach for new heights, seek breakthroughs in new technologies – some that we can't even imagine yet.

Let me give you just a few examples. Earth science is all about innovation. All of our satellite instruments are, more or less, one-of-a-kind experiments in seeing in new ways. And the same could be said about our science missions that explore our solar system and look beyond it.

The Global Hawk, a gift from the – a gift from the Air Force, has now been – it's not a joke – (laughter) – they really did – the Global Hawk, a gift from the Air Force, has now been made into a drone for science. Its flight capabilities come from the military, but the way we've been able to zip it around the U.S. is new, and the science that it's able to perform, like crisscrossing a hurricane a dozen times or more, has not been possible before.

How about measuring the changes in ice sheets all over the world with lasers? ISAT did that, and we have a new, improved ISAT II on the drawing board, now at the Goddard Space Flight Center. Then, there's the GRACE pair of satellites. Who would have thought that we'd be able to learn about our world by precisely measuring small mass changes across the Earth? Already they've measured declines in the water aquifers under California and Pakistan. This has never been done before.

We were deeply saddened by the loss of the Glory mission last week. My heart goes out on a very personal level to the scientists and engineers who expended so much of their intellectual capital and passion on Glory over the course of its development. Some of our folk had been with Glory for 10, even 20 years. The good news is that eventually those people will be actively working on the innovations for that next mission. That's the truth – that's the thing about innovation. It keeps going.

NASA is also innovating our development, acquisition and program-management approaches to ensure continued U.S. leadership in human spaceflight. Our Commercial Orbital Transportation System program (ph), among many milestones, last year helped SpaceX become the first commercial company to launch a capsule, orbit the Earth and retrieve it intact. SpaceX and Orbital will be the first to carry our space station cargoes to space. But there are many others working on their own systems and also the supporting businesses for commercial space, both cargo and crew transportation.

We have taken another major step with the successful commercial cargo and Commercial Crew Development, or CCDev, efforts during the past year. As we direct resources toward developing these capabilities, we not only create multiple means for access in low Earth orbit, we also spark an engine for long-term job growth.

NASA is counting on American industry to come through, as they have time and time again, for this country. And we're facilitating the success of this emerging sector of the

American economy. The CCDev acquisition strategies including innovative pay-for-performance milestones, a fixed government investment, the use of negotiated service goals instead of detailed design requirements, a partnership approach that includes private capital investment.

Among the current participants are Blue Origin, with its launch-aboard system, and Sierra Nevada, with its Dream Chaser space vehicle. We have to embrace the innovators who may be able to do things more cheaply and effectively than we can. That can be nimble and entrepreneurial and pass those benefits on to us.

New capabilities in commercial space for crew and cargo must – must succeed. And I have every confidence they will. NASA is also putting in place fresh acquisition and program management approaches, including the way we manage risk to reduce recurring and operations costs in both the multipurpose crew vehicle and the space launch system.

It's going to be a challenge to get these systems flying on the timetable that's been laid out for us. This streamlining process is one of the ways we're going to help move these schedules along. And those programs themselves, the new rocket that will allow humans to once again reach beyond low Earth orbit and the capsule in which they'll travel, require us to think in new ways, create new technologies and meet the challenges not only of the mission at hand, but the broader needs of our space program across a generation.

So our innovations will not always be technical, but will involve new ways of looking at our work. We're going to do what government does well: seed the future, help push things along to the next level, accelerate a market that might otherwise be just too big a nut for industry to crack on its own, drive the development of new technologies to reach those far-off destinations in the solar system and to make discoveries in other galaxies.

At the end of the day, we're going to accelerate what people think is possible. Speed is the vibrancy of innovation, and inspiration is a constant companion to innovation. How many people entered a STEM career because of Apollo or because they saw an astronaut doing a spacewalk from a shuttle or the International Space Station or because Hubble blew them away with an image from another galaxy?

Our nation has made great progress through its history by developing innovative solutions to the enormously difficult challenges it has encountered. The grand challenge to build an intercontinental railway or to land a man on the moon and return him safely to Earth not only utilized our best talent, but also created new technologies and innovations.

These achievements also inspired generations to pursue challenging goals, created new industries and ultimately improved our country and the world. Similar opportunities are in front of us now. However, we won't get there without being innovative and willing to take risks.

Robert F. Kennedy once said, and I quote, "Only those who dare to fail greatly can ever achieve greatly," unquote. This thought applies to NASA today just as much as it did to the NASA of the 1960s. New York Times journalist and critic Brooks Atkinson once aptly said, I

quote, “This nation was built by men who took risks: pioneers who were not afraid of the wilderness, businessmen who were not afraid of failure, scientists who were not afraid of the truth, thinkers who were not afraid of progress, dreamers who were not afraid of action,” unquote.

These are the facets of the larger picture of innovation at NASA. It’s about technology, engaging a broad community of innovators, building fresh perspectives and embracing change. We’re looking forward to many more years of harnessing the power to lead the world in new ideas and technologies that will make global space enterprise a reality.

NASA is up to the challenge. I just hope all of you are. Thank you very much. (Applause.)

And I think we’re going to do questions? We will try Q&A for a while, until they pull me off. How’s that?

Q: General, thank you very much. My name’s Greg Schuckman; I’m from the University of Central Florida. And I want to thank Bobby for coming down last week and inspiring a whole folk – a lot of folks, both our students and faculty and the suborbital folks that came in.

When I was thinking about Dr. Hamre’s introduction of you and you saw the grin from ear to ear that he had when he was talking about how inspired he was seeing John Glenn orbiting the Earth – and no, I wasn’t there either, but I saw the movie.

ADMINISTRATOR BOLDEN: It’s a good movie.

Q: And in your remarks today, and in every remark, I’ve heard you and almost every administrator before you talking about how NASA has inspired students and inventors to go and reach further and to innovate. The one thing that I was puzzled, when I looked at the budget, was, there are two areas that suffered a cut: human space operations, obviously – and that’s because of what’s happening in Kennedy; but the other was education. And it’s almost 25 percent lower than FY ’10. And I know that NASA is sort of the driver for STEM ed and inspiring all the people. So there seems to be a little bit of a dichotomy there.

ADMINISTRATOR BOLDEN: The education budget line is interesting because it’s not a – it isn’t a cut. It’s the same – minus a few million dollars, it’s the same as it has been for the last few years.

What happens in budgets? Any budgeteers in here? Or congressional staffers? What happens to NASA all the time is that we always get plussed up, particularly in the education budget. So when you go – like, our budget is, I think, $138 million for education in the FY ’12 budget, which appears to be a decrease from 180-some-odd million (dollars). That extra amount was actually put on top of the 130 – 143 (million dollars) that we requested in fiscal year ’11. And we never turned it down but we don’t plan on it.

And so when we put our budget together, we tried to be consistent in the budget that we put for 2012. So it looks like we took a cut or we decided we were going to spend less on education. And we really didn't, but we can't count on a plus-up, that Congress is going to stick on it. They all have special programs that they like.

And I think everybody in here knows, whether you've been in an organization where you received a – you know, you're working with a federal budget or not – the plus-ups are not always helpful, because with them comes the responsibility of carrying out the program that that plus-up was put in to carry out. And sometimes it's – the plus-up is insufficient to carry out the program.

I think there was a question over there. Was there? What, was it that dull?

Q: Hi. Jeff Bowles (ph), Futurom Corporation (ph). I want to ask how, as an agency or even as a country, we balance the need to accept risk with, particularly in these fiscally tight times, the perception that taking risk and failing is seen as a waste.

ADMINISTRATOR BOLDEN: We have to – one of my jobs is to help people understand that failure is an indication that you did take risks. When I talk to college – when I talk to students from kindergarten through graduate school, I always tell them three things. And Colleen (ph), you will attest to this – I've talked to her graduate students. And people say, what would you advise a student? I say three things. Study really hard; work really hard so that you become the best at whatever you do; and most importantly, do not be afraid of failure.

We are a people right now who, I think, are afraid of failure. I spent some time yesterday morning before we had an incredibly beautiful landing of Discovery down at the Kennedy Space Center, talking to the folk in the launch support processing team, who actually were the people that did the processing for the Glory spacecraft that we lost last Friday.

I mean, they were devastated. As I mentioned, some of them have been with that program for two years. Some people have been with it for 10 years. There are some of the scientists who have been thinking about Glory and working on the concept for 20 years of their life – a lifetime. They understand risk. But even they were devastated when things did not work out.

We have got to help educate our populace that if we are going to lead the world, we've got to be willing to, every once in a while, accept that we don't get where we thought we were going. So that's one of my jobs, is to address the issue of risk and help.

I don't want anyone to become comfortable at all. But I do want them to understand that just because you failed does not mean that you wasted money or you wasted opportunities or other things. I think you waste opportunities when you're afraid to fail and you won't take risks.

Yes. And I'll let you all with the mics – you can see them as well as I can, so just take them.

Q: Thank you. That was a very inspiring, informative talk. My name's Christopher Cross; I'm from the National Environmental Education Foundation. And I just wanted to bring everyone's attention to – there was an editorial in Science; I think this was the February 25th issue. And the title was "House cuts to DOE national labs that also hamstring industry." It lists a couple of examples here: pharmaceutical companies using X-ray crystallography at Oregon National Lab and also how the petrochemical industry uses advanced photon sources. Basically, they use DOE's facilities for their experiments.

One of the arguments in here is that decreases in funding for these national laboratories will shut down this source of experimentation for these industries, possibly even prompting them to outsource their facilities overseas. So I'm just curious if maybe you have a couple examples that are similar to these examples that are listed in this editorial, in terms of –

ADMINISTRATOR BOLDEN: Things that we're going to lose or could lose with the reductions in the budget?

Q: Yeah. Specifically, that could affect industries and their ability to compete and stay in the United States.

ADMININSTRATOR BOLDEN: You know, we're actually the – because all of this is supposition and my job is running the space agency and trying to make sure that we keep astronauts safe and we live within our budget and that we comply with the essential elements of the 2010 budget, it may be foolhardy, but I have really not given time to think about things that we're going to – that we could lose. It's too early for me to give up.

So what we're looking at is ways that we can take the funds that we have. And when we build the 2012 budget, we told ourselves, okay, what would be – bad case would be – and Bobby will tell you. We said, what could be a bad case? And a bad case, when we built the 2012 budget, was that you would have to live under a 2012 spending level – 2010 spending level.

So we sized – essentially sized the 2012 budget to be roughly about what we thought the – you know the 2010 spending level was. Turns out, that's a good case. And so we don't see – with the exception of some very specific things that weren't in the 2010 appropriations, like space technology, which didn't exist then, or some of the other things, we don't see yet areas where we're going to have to take things off the table.

Now, we have, in the individual directorates – I mean the responsibility of the associate administrators is to say, okay, if I am forced to reduce something, what are the priorities that I want to maintain? And so if you go into any directorate, they would be able to show you a prioritized list of projects and programs. But right now, we've not gotten to the point where we see that we want to take anything off the table.

Can I go back – I just thought of something. I can give you an example of where we are looking forward and having to do it. The decadal survey in planetary science just came out Monday. And what was the top priority for the decadal – top two? One was a Mars mission that we're flying with the European Space Agency, and second in priority was a mission called

Europa, you know, that goes to the moon Europa, that we think is – I mean just covered in water and has all these geysers and all other kinds of stuff. And I'll stop there because I'll tell you something wrong.

But what was evident in the language in the decadal survey and what we are already in the process of doing with our European partners and saying, we have to change the way we do business. We have to descope the missions. Because we cannot do them to the level of complexity that they were originally planned when they were envisioned, say, several years ago.

So a flagship mission that used to – we used to start out saying we're going to have a flagship mission that's going to cost $3 billion. We have told ourselves that's a nonstarter. So we will fly a flagship mission, but it's going to have to find a way to descope so that it comes in a $1 billion flagship mission, our portion of it.

And we're asking our European partners to do the same. You know, look for ways that we can both descope. And if I can give you an example, maybe not an actual example, but an example would be a mission to Mars that was going to have two rovers. Why? If you can't justify the fact that you absolutely have to have two rovers, then why not go with one? And why not let one of the partners provide the rover and the other partner provide instruments or something else?

So you're going to see a lot of that going on. And that's already started happening. So that may be an example. And that – it does trickle down into industry, because we don't build stuff, for the most part, you know? Goddard does – JPL does a little bit, but industry builds most of what we do. And so if we're going to descope a mission, it means there's going to be something less for industry to do. But we're all in this together. Yes?

Q: Charlie – Russ Barters (ph), Charlie.

ADMINISTRATOR BOLDEN: Yes, how are you doing?

Q: You know, everybody, it would appear, would say technology is great, who wouldn't want to do technology? But there's some people on the Hill, especially in the Senate side, in the CR, who have zeroed out technology. What do you do if you're faced with a cut to zero in technology?

ADMINISTRATOR BOLDEN: I was informed this morning that the newspaper said it zeroed it, but not in reality. Because it's a CR, a continuing resolution. And Bobby, help me here, because you were in the same meeting I was. Things are frequently silent in a CR and all that means is we didn't change anything. So things that are – if it didn't specifically say, you know, this is go to from that amount to this amount, then we have flexibility.

And so our understanding is that we have the flexibility to conduct, for the most part, the technology – the space technology initiatives that we want to do as long as we can go in and communicate with our stakeholders in the Congress and help them understand why we're putting priority on that.

So the space technology was not zeroed out in the continuing resolution. They didn't plus it up and they didn't take anything off. They gave us flexibility to – you know, as long as we satisfy their concerns that we not waste the money, I have the flexibility to move money around so we can –

Q: That's good to hear.

ADMINISTRATOR BOLDEN: But now – and again, what I will emphasize for everybody is if we don't talk to the stakeholders, if we don't travel to the Hill and talk to them, you know, about why we want to do something – Bobby and I spend most of our time back and forth to, you know, to staffers and members and everybody trying to help them understand why this is a higher priority than that and why we're going to do this now.

And in my comments, you heard me talk about you were going to see us do incremental programs. A heavy-lift vehicle – we're not going to build a 130-metric-ton, heavy-lift vehicle. We can't, and we continue to negotiate and discuss with the Congress why that is not necessary. Not only is it not wise, it's not necessary for us to build a 130-metric-ton, heavy-lift vehicle right off the bat.

By the time we need to go – we're going to Mars or to an asteroid, then you need a 130-metric-ton vehicle. And the – because we will allow technology to help us get there, a 130-metric-ton vehicle that's going to space and going beyond low Earth orbit in 2030, I mean it may weigh half – I'm exaggerating here – but its weight may be significantly less than what a 130-metric-ton vehicle is today because we're using composite tanks. We're using smaller components.

If you look at Shuttle – one of the things that we wanted to do in the Space Shuttle and we just never got there was go to – instead of hydraulically actuated control surfaces, go to electro-mechanically actuated control surfaces, where you get weight down, you get rid of a lot of the risk of damage to hydraulic lines and the like. We just were never able to get there.

But that would have been a huge technological leap in the Shuttle program. But that would have been a huge technological leap in the Shuttle program that we think would have reduced long-term cost, would have reduced weight and every – every pound you take away from the launch vehicle is payload you can take to orbit. So a 130-metric-ton vehicle is not a 130-metric-ton vehicle of today.

Q: Susan Pearce, and I'm retired, Lockheed Martin, and I am constantly beat up from people who say that the space station is just a total waste of time and money and we haven't done anything there that's worth anything. Could you name what you think are the most significant discoveries or innovations that have come out of the space station? And by the way, I haven't heard you mention the word space station.

ADMINISTRATOR BOLDEN: Yeah, no, I did. I said it a couple of times – International Space Station, I did. And I even said that some of the technologies that have come

out of the International Space Station or the fact that Spacewatch from the International Space Station has inspired people.

However, the two that I would prefer to give right now because they are two that are the closest to actually changing life here on earth, one is a salmonella vaccine that is coming about by – Julie, you may help me here – it's a company out of Arizona. AstroGen (ph)? Is that it? Okay, I'll let you say that. That's right, Bobby?

They took some salmonella bacteria to orbit and what they found – it was a theory, and what they found was that it becomes incredibly virulent, in fact, it gets really bad – it grows incredibly fast. When they found that out, they were able to extract the gene in the salmonella bacteria that grew radically on orbit that they now will use as the basis for a salmonella vaccine, potentially. And they are now ready to enter human trials.

Using that same biomedical technology, they're looking at a potential vaccine against MRSA, which is the, you know, the hospital infections, the micro-immune, the bacteria in hospitals that gets immune to antibiotics and stuff. So those are just two examples. And they came about because of experimentation on the International Space Station.

You've got another example?

MS. : There is a – there's a system on board the space station which exists on Earth, but is not utilized the way it is on the space station. It's called the wastewater recycling system and it stands for exactly what you think. We do process our wastewater – human-generated and otherwise – and we then retransform that into drinking water.

And for having tasted it, water tastes like water, H2O is H2O wherever you are. It is the first time that we're using a system like that on a daily basis. And who knows where in the world this kind of system is going to be extremely useful in the decades to come?

ADMINISTRATOR BOLDEN: Thanks very much, Julie.

(Off-side conversation.)

Q: Real quick question for you. Looking forward at the possibility of commercial crew or cargo transport at the station, is – given the supply, demands of the station is that probably won't be possible to support five or six, you know, vibrant competitors. You know, you have to have a very limited number of companies that can successfully compete with that level of demand.

Going forward, as you're sort of looking towards this space station in the latter half of the decade and concerns about allowing those companies to keep operating in a viable way, there might be a temptation, for instance, to switch more cargo delivery to commercial providers. Would that have the consequence of sort of freezing out European and Japanese cargo deliveries to the station?

ADMINISTRATOR BOLDEN: We can't – let me give you this example. And I am told that when we take the final payload to the International Space Station with STS-135, it will have 14 vehicles' worth of cargo on board, whether it's in volume or mass or anything else. So you know, we're a long, long way from being able to replace Shuttle as a transporter of cargo to and from the International Space Station.

We can't – we could use many, many more providers for cargo. Cargo is not a problem. You know, the issue will become commercial crew. And one of the reasons that we have to facilitate the success of the commercial crew industry as rapidly as we can is because the International Space Station may go away, you know, in 2020. We will probably end up certifying it to 2028.

My plea to the commercial industry is for people to stop thinking – when they think about commercial space, stop thinking about launch vehicles. Everybody always thinks about launch vehicles. We need destinations. So you need – you need an on-orbit infrastructure to which the launch vehicle providers can go. And you're absolutely right. The government cannot sustain four, five, six launch providers. We're looking to have maybe two when you talk about commercial crew. It is up to the industry, then, once we, as the anchor tenant, facilitate their success, it's up to them to decide that they want to create – they want to enlarge the infrastructure.

I'll take you back to the – and I'll keep it short – I'll take you back to 1972. I wasn't with NASA, but I was there, you know, when I heard about the Space Transportation System. And it was briefed to then-President Richard Nixon. And Dr. Hamre, he probably wasn't there either, but he will know even more precisely than I do, and Colleen's (ph) probably studied this. So she can tell me whether I'm wrong.

But I am told that in 1972, when the NASA administrator and deputy administrator went in and briefed President Nixon on the Space Transportation System, the concept, it was going to be a three-pronged system: a launch vehicle, a space shuttle that would be used to provide routine access to space, at least one station – space station that then, its intent was to be the weigh station where would fly smaller payloads, components of a deep-space exploration system.

We would fly it to the space station, assemble it on orbit and then go back to the moon, go to Mars, go to other planets, do all the kinds of stuff you wanted. And because you would also want to move from one space station to the other as more would develop, then the third component was an Orbital Maneuvering Vehicle or a – I think it may have been called an Orbital Transfer Vehicle.

So it was a three-pronged system. President Nixon was just excited, said, that's what I want to do. And then as the story goes, and it's probably – this is probably myth, the next day, the NASA administrator got a call and said what the president really meant was this is the amount of money you get. (Laughter.) And the rest is history.

And so you know, NASA was stuck with, okay, how do we do this? How do we prioritize? Well, what would you pick? You don't have an STS, a Space Transportation System. And many of you, didn't know that that's what it used to be called. It was not always the Shuttle Transportation System. I think it was after the Challenger accident that we moved away from Space Transportation System as NASA decided we just cannot afford an Orbital Maneuvering Vehicle.

We're going to get a space station, but the system that was briefed to President Nixon in '72 is just not going to materialize right now. So we're just going to call it what it is. It's the Shuttle Transportation System. But that was where we were in the '70s. That was a vision that had good basis for it. Good sound – I mean people had done their business models and everything. And it had a very sound basis.

Here we are, back again, with another opportunity to do that. And the nation can decide how to do it smartly and do it incrementally and say we're going to do it incrementally right off the bat so we stand a chance of success and we not do like we did in 1972, when we were going to build a system all at one time, which was an impossibility.

You heard me use three terms: affordable, sustainable and realistic. Affordable – we argue about what affordability means around NASA headquarters all the time. It means – it means a lot of things to a lot of different people. To me, it means it's got to fit within the budget, plain and simple. If the budget says I have this amount of money, I can't spend any more than that amount of money and I can't count on somebody coming in and giving me a plus-up, okay? So I've got to plan to the budget.

Sustainable means it's got to last more than one administration, more than one Congress, you know, more than one budget cycle. And in order for it to be sustainable, I need destinations, I need infrastructure, all this other kind of stuff. And I have to have it cost low enough, lifecycle cost, that I can show how I'm going to pay for it from beginning to end.

I can't do like we have always done things – the Marine Corps and NASA. I'm a Marine. I think most of you know that. In the Marine Corps, if I can get something started, then in my mind, it's sustainable. I've just got to get it started and then I can sustain it. I think NASA's historical mentality was if we can get something started, we can sustain it.

You know, the Congress will come to our rescue, the American people will come to our rescue. I have said we're going to do something that's affordable, sustainable – truly sustainable and realistic. If it doesn't pass the sniff test for realism, then we're not even going to undertake that. So that's kind of where we are.

I really appreciate the time you've given me and look forward to having an opportunity to come back and talk again. I'm looking forward to the panel. So I'll step aside. Thank you.

(Applause.)

JAMES LEWIS: Can I ask the panel members to come on up and then we can move to phase two of this? I'll start introducing them while they're heading up here. And Robert Braun, chief technologist at NASA, long experience in the space community – I'm sorry – I won't even list all the programs, it's practically every one you'd know. Georgia Institute of Technology and now back at NASA, so a true expert in this stuff.

Chris Caine, formerly of IBM, now of Mercator XXI, a professional corporation that works on innovations. He's one of the innovation gurus in Washington. You probably don't know that, but he's been working this for a long time, mainly at IBM.

And then finally, Ty Taylor, Capitol Advisors on Technology, where he's the president. Again, long experience with space, long experience with NASA, long experience with innovation and a leader in the innovation field.

So what I've asked is that our three panelists each take 10, 15 minutes or so to make a few remarks on the themes that the administrator's laid out and then we'll have time for a few questions. So Bobby, do you want to start?

ROBERT BRAUN: Sure.

MR. LEWIS: Cool.

MR. : Do you want to come up?

MR. BRAUN: No, no, this is fine. I'm much more comfortable. You can hear me okay? Okay, great. First of all, thank you very much for inviting me and for including me in this event. It's great to see so many people here interested in technology and in innovation.

Just real quick about me, I'm an engineer. I've always been an engineer. I started my career at NASA wanting to build things, wanting to build systems that would actually fly to Mars. I worked in some aspects of planning our human exploration program, plans to one day send humans to Mars. And I've spent most of my time working in the robotic exploration program, actually, building systems that landed on Mars.

After about 15 years with NASA, I left and went to Georgia Tech, where I'm on the faculty. I'm a professor in the School of Aerospace Engineering. And you know, I went there, really just to be honest, because I love working with students and I don't know if you've been on a college campus lately, but there are students all around this country interested in science and technology and innovation and engineering.

And the greatest thing to me about these students is that they go into these fields, you know, not for the money. You know, you ask any of them. They go into these fields because they want to change the world. They want to invent technology. They want to build the future. And what the administrator – what General Bolden just spoke about was the way that NASA can build the future.

And so about a year ago, he asked me to come back to NASA and serve in this chief technologist role. You may be surprised to know that it's been about a decade since NASA had a chief technologist. So I more than happily came back. NASA's a fantastic place. It's always been part of my family, actually, to be a part of NASA.

There are innovators all in and throughout NASA, at the NASA centers, in the small businesses that work with the agency, at the nations' universities, in large companies. It's a tremendously talented place and it's a pleasure to work with people at NASA and in the larger community and to get to represent the agency in this way.

When I think of NASA, I think of three long-standing core competencies that make the agency somewhat a special and unique place in the federal government. And these core competencies go all the way back to the space act and the founding of the agency. And they are a focus on research and technology, focus on flight systems, building spacecraft, building hardware and mission operations.

And if you think about NASA, whether you think about the human exploration program or the science enterprise or what we do in aeronautics, it's really the integration of those three things, those three core competencies that makes NASA a unique place.

In my view, over the past decade, the research and technology side of NASA has been a little bit down. NASA was rather focused on the near term, on the very next set of missions. And so what I've been doing over this past year is trying to reinvigorate that research and technology focus, the research and technology people that are all throughout the agency.

Now, by the way, when I talk about these three core competencies, I don't really expect the budget to be divided into three equal pieces. Research and technology, I think, will always be the smallest slice of NASA. It probably always should be. You know, make no uncertainty about that.

But it does have to exist. The budget for research and technology at NASA does have to be large enough that there's a critical mass of activity, that there are enough people thinking about the next set of missions as well as the people thinking about you know, the very next mission.

As NASA's chief technologist, I get to think about the future all the time. And I'll tell you, NASA has a very bright future. NASA's future in science, aeronautics and in human exploration is bright. The missions of the next decade are to – are grand in scope. They're bold in stature. And NASA is an agency that can accomplish these missions, many of the missions that General Bolden spoke of.

But we'll only be able to accomplish these missions, the missions of tomorrow, if we make the right investments in technology today. And that's – to be honest – that's the pleasure that I get to have, me and a small group of people here in Washington and spread out across the NASA centers. We get to think about tomorrow and think about making those right set of technology investments.

And we're going to do that by engaging innovators all over the country. This nation is not short on innovation. This nation is not short on innovators. We just need to invest in them. They're at the NASA centers. They're at universities. They're at small businesses. The engineers and scientists in this country are a very talented group. And NASA is one area of the federal government where we can engage them, where we can make these investments.

By focusing a small portion of NASA on research and technology, we're investing in NASA's future missions. But just as importantly, we're building the nation's economic competitiveness. We're inspiring young people to continue to go into educational and career paths in science, technology, engineering and mathematics.

We're building on our nation's global leadership position, our position as a technology leader and all of the benefits that come from that, whether they be national security or our standing in the global world.

In fact, when I – you know, many people talk to me about the 1960s as the golden age of NASA. I don't buy it; I'm sorry. I wasn't there – (chuckles) – so maybe that's why I don't buy it. I've only witnessed it in black and white, right? I was alive, I should point out. But – (laughter) – I wasn't – I wasn't – other than watching it on TV, I wasn't that engaged.

The reason I don't buy it – the reason that I don't buy, you know, that NASA, that these are tough times and so we can't make these investments for the future because we have to worry about today is because they didn't do that in the '60s. You know, when we were building – when we were building and flying Mercury, they were developing Gemini. And when they were building and flying Gemini, they were designing Apollo.

And all throughout the Apollo program, we were making investments in technology. Something like 10 percent of NASA's budget in the '60s was focused on space technology. Over time, those investments have shrunk. And I do think it's vital for the agency – for an agency that's focused on the future, for an agency that the American public expects to be bold and to be dreaming of the future, I do think it's vital that NASA make those small set of investments today to enable our future missions.

And so that's really what my office is all about. That's what we're focused on. I should point out that it's not just my office. This is an emphasis across the agency. I do work with all the NASA mission directorates in this. There are technology investments being made in the Science Mission Directorate. There are technology investments being made in aeronautics and certainly in human exploration.

We plan to fully utilize the International Space Station, both as a scientific laboratory, but also as a national lab where we can prove the technologies required to go out beyond low Earth orbit and go after some of the missions that General Bolden described. So with that, I guess you can probably understand why I'm excited about this position and, more importantly, excited about what I believe is a bright future for NASA and for this country in aerospace technology. And I'll pass it on.

MR. LEWIS: Great, thank you, Chris. Do you want to go – it was nice to hear somebody who wasn't looking in the rearview mirror, I have to say. Go ahead, Chris.

CHRISTOPHER CAINE: I guess fortunately or unfortunately, I was there in the '60s and I do remember it and not just on television. I'm glad that you've succeeded us, though, so – it's a privilege, actually, to be here this afternoon and to be participating in such a great program. And General Bolden, your remarks were great and I want to support probably just about everything you said, just about.

I think it's – I look at this from a marketplace perspective about innovation and that's what I bring to the table after 30 years, coming from the marketplace, the global marketplace, most of it spent in the technology sector of the marketplace. And I guess what I'd like to just start with, Jim, is to say that there is a worldwide competition for innovation taking place today, not necessarily the same environment that took place in the 1960s, where we had a much more bipolar world, okay?

NASA no longer is alone or just in a one-on-one competition. NASA now is competing with many countries for this worldwide competition for innovation. That should be good for us. We have probably the strongest hand to play, if we know how to nurture and invest in that hand, which are some of the things that the general was referring to.

And when Jim asked me to participate in this, he said, I'd like you to you know, think about what is government's role in enabling innovation and spurring innovation for both our country's benefit but also our society's benefit as well? So I think what I'm about to give you are a couple of thoughts about, from my perspective, the marketplace perspective, this worldwide competition for innovation, government's role on the 21st-century innovation marketplace.

I want to highlight two. One is, it's important for government – and when I say government, I'm talking about the U.S. government, I'm talking about both branches of the U.S. government, legislative and the executive, because the executive has to design its budgets and propose it and the legislative branch has to validate, approve and fund those budgets. One can't operate nor will it operate without the other.

Our government has to create the conditions for attracting worldwide investment. And this probably has to be the most important priority, in my opinion, for the United States in today's world, creating the conditions for attracting worldwide investment. We should be the best in the world at making policy decisions comparatively, which means we have to understand who's competing with us, what they're doing.

And if we're going to attract investment, we have to have an offering that supersedes anybody else's offering if we want to have the resources, the momentum, the energy, the inspiration, the capacity to win in this worldwide competition for innovation. Now, what do I mean by that?

Think and act comparatively, all right? My proposition is we should be benchmarking everything we're thinking about doing, how much to invest in NASA, how much to spend at the national labs, whatever it might be, whatever our tax policy, we should benchmarking that against the G20 nations. It's 85 percent of the worldwide economy in today's environment and it comprises both our closest allies and our strongest competitors.

So if we're not making policy decisions in a comparative way, benchmarking ourselves against 85 percent of the global economy, which creates a community of both allies and competitors for us to be mindful of, I think our decision-making process and our fiscal and public policy is misguided.

I don't think we do that very well in Washington. I've been in Washington for 30 – over 30 years. I think we have, you know, rightly been proud of being the largest economy in the world for a long time, a number of decades being the most successful economy in the world and country in the world. The game has changed. We have to think about making decisions in a comparative way, benchmarked against the practicalities and the realities of what's happening around the world.

I'll give you a couple of examples. Unfortunately, the first one's a negative example. The president, to his credit, proposed in his budget in the State of the Union address, making the R&D tax credit permanent and making it more robust. Okay, that's a good thing to do, I guess, if you're going to be the best in the world or if you're going to number one, two or three. But why to enhance and to make permanent something that's mediocre is beyond me. That's not playing to win.

And at best, we will – our R&D tax credit, which was the first in the world in 1981 under the president's proposal will go from being number 17 in the world to number 13 in the world. I find that unacceptable for a country who has the ability and the desire to be the best. It's an example of a public policy decision and strategy that will only kick the can down the road and continue a lack of exceptional performance.

And it goes back to attracting investment, worldwide investment in a worldwide competition for innovation. We have to have the same orientation toward government R&D programs and we have to make choices, absolutely. You can't win without making choices. But we ought to compare what we're betting on in our government R&D programs against what the other G20 countries are putting their money into.

And this is, I think, the International Space Station is a good example. We have an idea, we've created a set of partners and we've chosen to pursue that strategy. That makes a lot of sense to me.

We recently did a study – Mercator XXI – about the investment criteria that large corporate decision-makers make about where to place their investments in the world today. And we meshed that and analyzed that against what countries are offered, against six different criteria.

In some of those six criteria, the United States – well, actually, in the six criteria, the United States only came out number one in one, the availability of skilled talent. But it's also diminishing in a comparative sense. In every other – in one other category, we're at the bottom. In every other category, we were average.

Now, the world has made players. That's okay to be not number one in every category, but it's not a winning strategy to be average overall when you're competing in a world of intense competition and especially in this competition grounded in innovation.

One piece of good news, which was when the COMPETES act was reauthorized, there was an amendment adopted into it from Senator Warner, which creates an obligation by the Commerce Department to do an annual study to the Congress about the relative standing of the United States from a competitiveness strategy perspective with other countries. Good thing to do, a beginning step for comparative policymaking.

The problem was the countries that were selected – (chuckles) – are not the competitors that we're dealing with in the 21st century. They're the competitors we were dealing with in the 19th century. So we have a few technical amendments probably that are needed here, but if it said let's look at the community of nations that make up 85 percent of the worldwide economy, let's say the G20, it'd be a lot more valuable thing to do than comparing us with the industrial manufacturing economies that we used to compete with.

So creating the conditions for attracting worldwide investment. Then the last – the next point is helping companies and entrepreneurs scale. Markets are global today. They're integrated today, they're instantaneous. They're digital and physical. And one of the major roles that government can do is to help our companies and our entrepreneurs scale to meet that playing field.

Growth resides outside the G7 countries, by and large. And there's been a reallocation of economic assets that's taken place in the last 20 years dramatically. It was taking place before that. And we need to help our companies and our entrepreneurs access that growth which resides outside the traditional markets that we're comfortable with. That is both a digital and a physical statement. And it has one of the tremendous opportunities, I think, and benefits the government can provide.

Number two would be focus equally. The general talked about disruptive technologies – absolutely. NASA's a great example of an incubator for disruptive technologies. But we need to focus equally on disruptive technologies and disruptive business models. And in fact, I – I would argue that disruptive business models are frequently more important and more wealth-generating than disruptive technologies.

And they don't – a disruptive business model can change the world and it doesn't have to use a disruptive technology to do so. Think about some easy examples, CNN, very disruptive business model, not necessarily disruptive technology. The iPod? Very disruptive business model, no disruptive technology, okay?

There's a small company that's about to turn the advertising industry on its head. It's called Personal. Your personal information is – using a metaphor – the currency of the 21st century digital world. Shouldn't you be giving access to that information to others versus others just taking access to it? Potentially very disruptive business model.

Two quick things: service sector, as important, if not more than the manufacturing and agricultural sector, both for the United States GDP as well as employment. Government can focus on innovative breakthroughs in the service sector. And last, securing the global technology supply chains. And here, I give great kudos to NASA. They're part of an organization called the Trusted Technology Forum, public-private sector partnership that's designed to focus on leading-edge best practices to secure global technology supply chains.

And in the hybrid infrastructure that we have today, with a digital and a physical infrastructure, nothing can be more important and it can be tremendously leveraging to have a secure, global technology supply chain that American companies and American entrepreneurs can use to reach that growth that is in those new areas of the world that's instantaneous.

MR. LEWIS: Thank you, Chris.

TYRONE TAYLOR: Well, hello, everyone. I, too, am extremely excited and grateful for being here. Not only am I a native Washingtonian, born and raised here, but I am also a former NASA-ite, as is my mother, who I didn't tell her about today's forum because I was afraid she'd be in the back going "that's my son." (Laughter.) So I didn't want to do that.

And in fact, I was so thrilled – I am not an engineer. I came out of college – in fact, I began my career with NASA as a cooperative education student and began my career in the comptroller's office. And the beauty of doing that is it's all about the money. And regardless of how dumb you may be, as long as you keep asking those questions until they're answered, you don't give away the dollars, okay? So they have to deal with you and you get smarter and smarter as part of the process.

I have to tell you, Chuck Wessner was going to try and be here. I'm stepping in for him. I'm a member of the National Academy of Sciences. I support Chuck on a number of various committees that I'll mention here in a moment. Chuck, for some reason, elected to be in Brussels today rather than here, but I cannot imagine why.

But I am indebted to him as I am, actually, to NASA for a wonderful career because much of what I've learned and applied in the private sector, quite frankly, I learned at NASA. And the essence of that is the can-do approach. You can do it, okay?

I have to tell you – I apologize to the gentleman who made the opening remarks to introduce General Bolden – the spirit, if you will, the excitement that's been alluded to that is somewhat, one would argue, was somewhat missing today. You know, I have been around the country and sometimes when the shuttle was up in the air and it lands, it's not on the front page like it used to be, okay? It's in the Metro section and I go, what happened?

You know, my kids promised they would never work for NASA because I'd come home every day and say, guess what NASA did for you? You know, you see that light bulb? That's NASA technology. You see this over – that's NASA technology. And all I was doing – and in fact, I even bought the little astronaut suits for them, okay, as birthday – they'd run around. I've got the pictures of all of that.

But I was – I was really thrilled, having worked on the space station program and been part of the headquarters team when the president said, go do it. It was a reincarnation – not quite the same – I wasn't there for the Apollo era. I had a chance to work for some of the people – some of the leaders of that time. But I have to tell you, it was – it was quite exciting. And I'm sure I drove my family and friends crazy about my enthusiasm about the – about NASA.

But I am also convinced that, in spite of the many financial challenges or economic challenges we have today, that with the leadership here of General Bolden and Bobby and others, that we can get back there. We can get back there. Because I've taken a pretty hard look at your roles and responsibilities, and you've got – you've got a – you got a big ticket there. But it doesn't mean it can't be done.

What I thought I'd do very quickly is try and reinforce some of the comments that have been made. From an academy perspective, benchmarking is very important to us, taking a look at how things are done both here and abroad. And quite frankly, that's what Chuck is doing in Brussels. He's taking a look at their innovation system.

One of the things that we've done over the last year or so is looked at a number of activities looking at clusters, looking at the need for photovoltaics, solar panels, energy-related kinds of things: Who's kind of doing the right thing and trying to document the best practices? All this is important and relative to NASA.

One of the key – I don't know if you remember Dr. Mary Good. She used to be the undersecretary for technology during the Clinton administration. And, as we all know, there's no longer a technology administration. But Mary chairs an – a committee that I happen to be a member of called the State and Regional Innovation Practices. But it's important because we're going around the country looking at those areas where we find that, from a regional perspective, the states are actually making investments, significant investments.

And I'm going to point out New York, Ohio, where you have high unemployment rates. New York is making investments in nanotechnology; Ohio is making investments in the manufacturing community. And they are making those investments to do exactly what you alluded to, to draw additional capital and to – and, as Bobby alluded to earlier, to create high-paying jobs.

And in the case of New York, where they're making those investments in the nanotechnology arena, they are, in fact – they put 2 billion (dollars) in, and they've been able to raise $10 billion worth of capital, private investment. In addition to that, they've got a $4 or 5 million plant being built outside of Albany. In addition to that, that's going to create about 1,500

jobs over the next five years, and those are very great jobs, good jobs, as opposed to some of the ones that are, you know, driven by the service – the service sector.

NASA, in my mind, continues to have a role. It always did. You know, if you – if you go back and you look at its creation, many of you know – those of you that have been along – around long enough knows it's job – the reason we have so many of our technology in the marketplace is because our mission was to, you know, disseminate to the widest practical – practicable extent our information. Now, could we have done it better back then? Probably. Can we do it better now? Yup. Yup.

Because the taxpayers and the nation needs for us to basically do more with less. That's really what this is all about. When you peel back the onion and you stop getting so excited about the technology and you look at what really needs to be done, and those organizations or states that are having some success, this is not the first time we've said we need to collaborate. This is not the first time we've said we need to partner.

What we're talking about is degrees of partnership, degrees of collaboration. We need to take it to a level we've never been before. Because generally speaking, if the R&D budget remains at roughly 2.5 percent of the GDP, which it has over some period of time, history says it ain't going to get much better. So how do we continue to innovate, create that atmosphere, that structure, and leverage the best minds that we have? And I don't think there's any question about it that historically, you know, we are number one.

I'm an aging jock. As I tell my daughter, my trash-talking ability far exceeds my ability to play basketball at this stage in my life. But I will trash-talk you to death, and I don't like to lose, okay? And I'm sure NASA doesn't like to lose. And I'm sure, from a big picture, the nation doesn't like to lose. But you do have companies from a global – I'm sorry, countries from a global perspective – Japan, France, Germany, Finland, others – that are looking at our best practices, leveraging what we're doing and beginning to do it better than us.

So one would say – in the old days, we always talked about industrial policy: You know, we can't pick winners or losers. Well, my guys, we sure can't sit on our keister, either. And so I think the investments that we are making, the investments that NASA is making, the structure that it's put together to try and accelerate the transition of technologies and get the biggest bang for the buck is the right way to go. And again, that's what I think our country is demanding.

So when I – again, when I look at this, it is – it is a lot more – it's not as much about technology as it is about the culture. And is the culture, we as people, going to enable us to be as successful as we have been in the past and go beyond? OK.

Yes, there's training. You know, I think we need to probably mix and match the people, the workforce, a little bit more with people in the private sector and public sector. And that's what you're getting when you really form these very strategic partnerships.

But it's going to take – you know, we talk about sustainability; it's going to take a sustained commitment. It's going to take strong leadership and it's going to take a sustained

commitment. We can't turn the faucet on today and 18 months from now go, oh, just kidding. You got to be in it for the long haul, even during the tough times.

And based on some of the research that we've done from an academy perspective, we think – we think Ohio and New York, New Mexico, is beginning to do some things in this regard. They're making investments in very difficult times for the long haul, and that's the right thing to do.

So I'm a little biased. Probably if Chuck were here, he'd say, Ty, you know, you're a NASA-ite. And you're probably, you know, being a little biased in your remarks on behalf of NASA. And we'd be the first to say that's right, OK? Because I've never been so proud of a federal agency, quite frankly. I'm a big believer in the public sector. My wife, although, sometimes calls me Mr. Private Sector now, I will add. But I really do believe that we've got it; right now it's about execution, OK?

So let me just stop there and, you know, we'll go with Q&A.

MR. LEWIS: thank you. Great remarks by all three panelists. I'm going to take the moderator's privilege and ask the first question, which is, the general mention, JPL and companies building things and how important that was. So I want to ask you, you know, one of the topics we hear about today is the decline in manufacturing capabilities in the U.S. How important is it to actually make things to be innovative? Where does manufacturing fit into innovation? What would you say about that? And clearly, for NASA, making things is kind of crucial to what you do, you know?

MR. : You want to just go down the row?

MR. : Sure.

MR. BRAUN: Sure. Sure. So I think the last part of your question is actually the answer. For NASA, it's not enough just to have a great idea and play in the sandbox. For NASA, we want to build something. For us, manufacturing is an integral part of what we do. We're talking about new flight systems, we're talking about operating these systems in the harsh environment of space. So it's a – it's a coupled problem.

Now, when you get into manufacturing itself, there's the manufacturing of a technology and there are the process improvements, business-practice improvements for the manufacturing sector themselves. And we're interested in both of those.

So just for example, NASA has developed some pretty impressive analysis tools that we use for process flow of the space shuttle down in Florida, or for assembly of the International Space Station. These are computer models, computer analysis tools that we want to make available to the manufacturing industry in this country so that they can use those same type of models for efficiency improvements across a wide range of sectors. That's something that will affect NASA and improve NASA's future products, but it's also something that will affect us, you know, across the United States.

MR. LEWIS: Chris, do you –

MR. CAINE: Critical, OK. It's critical to – in order to be competitive, to manufacture something. But I think what we've done over the years is focused so much on the manufacturing piece, almost in isolation of what extends the economic – the high economic leverage of manufacturing. In today's world, where manufacturing is getting increasingly computerized, automated, employing fewer people – in order to keep that going, you have to have a high-skilled workforce that should be the best at manufacturing-services expertise.

And we don't really talk a lot about manufacturing services – and that's where the premiums are. That's where – in the marketplace today, you get – companies make a lot more money off of their ability to support the $4 billion nanotechnology fab in Albany through services than they do by running the fab, because the fab is going to be pretty automated. And there'll maybe be 600 people in the fab, running the – in the – kind of a classic manufacturing sense.

Yet it – around it is a hugely leverageable ecosystem of talent and services, and we don't really think about that very much.

So manufacturing's critical. But to extend its economic – high economic leverage, it is the ecosystem – and what I would point to is the services that come from that. So.

MR. LEWIS: Ty?

MR. TAYLOR: Can't argue with its importance. It's been part and parcel of our nation's growth in terms of the manufacturing sector. I think you're right, Chris; that's a good point about the premium. There are only going to be so many high-tech jobs working on the floor, okay, in the facility itself.

But I also think, from a park or from a regional-cluster perspective, there's an opportunity – you know, we all know there are x number of NASA centers that have various capabilities. And I think there's an effort, be it manufacturing or be it anything else, for NASA to strengthen its relationships at the state and local level to enable it, again, to capitalize on the knowledge space, to capitalize on the experience and leverage those dollars.

But manufacturing is key, no doubt about it.

MR. LEWIS: (Off mic.)

Q: Thank you for your presentations. My name is William Bennett (sp). I'm an energy lawyer in Washington, D.C., with the Federal Energy Regulatory Commission. And I'd like to ask you a question about the innovation process and management of the innovation process.

If you were going to put together a team that is to become a high-performing innovative team, what kind of people would you want on the team? And then secondly, if you were going

to invest a lot of money in a team over a long period of time, or a company over a long period of time, what kinds of things would you want to know about the way in which the company managed the innovation process in order for you to invest money in that company over a long period of time?

(Off-side conversation.)

MR. CAINE: Okay. (Chuckles.) So let's talk about people. I would want people who have skills that look like that: a "T," right on the top, deep down to some subject-matter expertise that makes them truly differentiated leaders.

In many organizations, we have people cobbled together who just look like that, an "I." And in today's collaborative, interconnected world, it is more important than ever to team and to leverage the knowledge, insights and experiences of your colleagues, because you can do it 24 hours a day instantaneously. And the people who have the best organizational models and the best leadership teams are doing that. And the ones who are slow to respond in reacting to the marketplace or to other developments are still stuck in a more industrial-era, silo'ed collection.

MR. BRAUN: If I can just add to that for a second, I think that's exactly right. I would also want a diverse team. I would want a mix of young people who are energetic, passionate, dedicated, who actually don't know how hard the job is; they don't know that it's impossible. (Laughter.) And I would want them to be mixed with some scarred old-timers, basically; people that have the experience in doing something like we're now trying to do in an innovative way. So they have some of the lessons learned and they have some of the experience.

And what you – what we're doing, actually, at NASA right now are – is trying to put together teams just like that. We have a lot of people at NASA that have years of experience, whether it's in human spaceflight or in other parts of the agency. And that experience is incredibly valuable. And we have young people, perhaps in our nation's universities or in small businesses, in some of the commercial companies that Administrator Bolden referred to. And we're really trying to match those folks up in a team environment.

MR. LEWIS: Okay.

MR. TAYLOR: Let me jump in. Let me answer that from this perspective. I actually have had the pleasure the last five or six years to run a(n) entrepreneurial summer institute where we train entrepreneurs – and the students, by the way, are from 20 – 19-, 20-year-olds to 50-somethings. And the one thing that we emphasize is – and from an academic perspective, we want everyone. We just don't want the engineers; we just don't want the chemists, the scientists, et cetera, et cetera. We want a little bit of everyone. Because when we mix them all up, the power of the – of what they can do is tremendous.

One of the things that we give them is patented technologies. And we ask them – we challenge them to come up with a secondary application of that technology, and we actually give them NASA technologies there as part of that portfolio. And it is amazing when you mix the grey hair with the young – to make your point – what you get. And they're – and they have to

function as a team. It is so critical: It's not about me, it's about the team. It's the overall objective.

So again, a diverse – a diverse cadre of people would be very important.

The other thing is, you know, I – if you look at – you know, I think of innovation; I also think of technology transfer, which I spent a fair amount of time working in. And if you look at some – at the universities that had the most successful commercialization business models, you see that those organizations are typically spinoffs from the university. They are nonprofits that operate outside of the traditional university bureaucracy.

And so we talked earlier about risk; we talked earlier about flexibility and being agile. And they, in fact, are able to be more responsive to the business needs. They are, in fact, able to hire and fire more rapidly. They're able to get the job done more quickly and more effectively. And I struggle sometimes recognizing – you know, trying to figure out whether or not the existing system – and I say that in a very broad sense, not just to include NASA – does, in fact – since we've got these big goals, is our system designed based on current challenges, both here and abroad – because things have changed over the last 20, 30 years – for us to be able to meet these overarching goals?

And I just don't know. I'm not – I think – I think maybe, you know, the old DARPA, ARPA, whatever, maybe even a separate organization away from the main – the main organization might be – might be a viable way to go, to some extent.

MR. CAINE: Could I add one thing? You asked a second question, about how – what companies are – what would be your investment criteria in an enterprise or a company.

Q: (Off mic.)

MR. CAINE: Right. I would not invest in any company that was not pervasively multilingual.

MR. LEWIS: There is a prize, by the way, if you stump the panel. So – (laughter) – you know, that was – you almost got it, I got to say; that – any more questions? Because we are coming close to the – oh, we have one – we have two more, I guess. Go ahead. Do you have time for – can you do – ? Okay, great.

Q: Hi, it's Mike Bevin (sp) with the Office of Space Commercialization at the Department of Commerce. Just had a question about the investment tax credits, I think mentioned earlier on the panel. There was a bill last year that was introduced in the Senate that talked about investment tax credits for commercial space companies emerging, and entrepreneurial space companies.

Just wondered to – if you guys could give us your thoughts on that and what you think about those. The assumption is you think that they're good – (chuckles) – but I know there's a lot of debate, so.

MR. CAINE: Well, at least in my remarks, I was referring to the research and development tax credit, all right? Investment tax credits are, you know, in the same family but not necessarily the same thing. You know, my general experience is that tax policy is important. It is a differentiator. But it's infrequently the controlling decision point. Infrequently; I didn't say never. This work we did that I referred to looked at six criteria that senior-level global decision-makers use to invest. Tax policy was – tax and financial policy was one of those six.

Q: (Inaudible, off mic.)

MR. BRAUN: That's a – that's a good question.

Q: (Inaudible.) (Laughter.)

MR. BRAUN: No, no, no, no, no, no. Let me – let me take – let me take a shot. So –

Q: (Inaudible) – type of prize?

MR. BRAUN: That is a – that's a very good question. You're close. How's that?

So let me – let me start off –

MR. : Just make something up. (Laughter.)

MR. BRAUN: No, no, no. No, let me start off by saying that there – first of all, there are many factors that are the same, OK? So things like – that you've already heard, things like the government's role in seeding innovation, things like the government's role in disruptive technology and R&D investments to spur – to spur along private investment and to spur along, you know, corporate investment in tech transfer and commercialization. Those are important in space, as they are in other industries.

I think, you know, for me personally, the primary difference in aerospace, on the NASA side of – civilian side of aerospace is that NASA does have a plan. NASA has a set of destinations that they want to one day send humans to. We have a whole series of decadal surveys in the sciences where we, you know, would like to go do some pretty ambitious missions to improve our scientific knowledge, our understanding of our place in the universe, the world around us. And so, you know, that provides a high-level strategy, if you will, for NASA's technology investments.

Now, many of those investments are then spun off, and they affect us, they benefit us, every day in our lives here on the earth. Many of those investments are spun off and commercialized into companies that are – that are quite profitable, into products and services, into high-tech jobs all around this country. And so in that regard, NASA acts, I think, like some of the rest of the government. OK.

MR. TAYLOR: If I may – and just, you know, the flip side of that is we know what the inhibitors are in some cases. The inhibitors are, you only build so many shuttles, okay, you only build so many stations. But clearly NASA has a very rich history of those technologies being disseminated into the marketplace.

You know, the – to (counter this ?), even the inhibitor point is that even if you look at the SBIR community, which is – represents a small portion of the R&D funding, you will see that many of the companies and almost – I think the number's as high as 80 percent of those companies that compete for NASA research and development funds through SBIR are also competing with the DOD community. And so you get some leveraging effect there that is also facilitating a greater dissemination of those technologies or those outcomes, if you will, from those investments.

MR. LEWIS: (Inaudible, off mic.) (Laughter.) Well, if we don't have any further questions, please join me in thanking – (inaudible). (Applause.)

(END)