# A Conversation with Dr. Bobby Braun Chief Technologist, National Aeronautics and Space Administration (NASA)

*U.S. economic competitiveness and a high standard of living have roots in decades of investment in research and innovation. As a premier federal research and development agency, the National Aeronautics and Space Administration (NASA) has played a vital role in the nation's innovation engine—continuing to extend its proud tradition of exploration and discovery. Cutting edge technology and innovation is more important today than ever before, as NASA develops missions of increasing complexity to understand the Earth, our solar system, and the universe.*

*We spoke with Dr. Bobby Braun, Chief Technologist at NASA, who was a guest on* The Business of Government Hour *about NASA's space technology program, its focus on research and development, forging disruptive innovation, and making a difference for the future.*

## On the Office of the Chief Technologist

The office and position are new. They were created in February 2010. In the past decade, NASA's research and technology investments have been reduced as the agency has become more and more mission focused.

What makes NASA unique is its three longstanding core competencies. They date back to the formation of the agency beginning with the Space Act of 1958. NASA has a research and technology competency; a flight hardware competency (i.e., the building and developing of flight hardware); and an operations competency (i.e., operating missions in space). Over the past decade or so, the research and technology competency has slowed down. We haven't made the critical investments required for that core competency to be healthy. My objective and most of my responsibilities as the Chief Technologist are to rebuild that competency. Only if all three of these competencies are healthy will the agency be healthy, and be the cutting edge organization that the nation expects. The Obama administration and the NASA Administrator want to rebuild the research and technology competency, so they created the Office of the Chief Technologist to lead that charge.

We have two major functions. We're responsible for integrating the technology investments across the agency and across the Mission Directorates at NASA, to ensure that we're doing things in a coordinated and integrated fashion. We're also responsible for managing a new budget line in the President's Budget Request for 2011, for the Space Technology Program. While subject to Appropriations deliberations, in the president's request, it's about $572 million for 2011, and about $5 billion over a five-year period. I report to the NASA Administrator. I'm his advisor in all technology matters across the agency. Technology is a part of everything we do at NASA, whether we're talking about aeronautics, science, or exploration. I'm in all of the major policy meetings. I take more of a strategic view for the future of the agency and the importance of technology in that future.

Secondly, I'm managing the new Space Technology Program. It is focused on long-term investments. We are investing in a portfolio of technologies that are broadly applicable.

These are technologies that could affect not the next science mission or the next exploration mission, but a suite of missions five or 10 years from now.

We're building on the lessons learned from organizations like the U.S. Defense Advanced Research Projects Agency (DARPA) and the Advanced Research Projects Agency–Energy (ARPA–E). We're applying this model within NASA, really for the first time. It's very exciting.

## On Challenges Facing NASA's Chief Technologist

I'd say the foremost challenge is cultural. NASA has been operating in a certain mode for the last few decades. That mode has evolved to one in which we take less risk with our missions and our systems. We still do great things in space and aeronautics, but the pace of that innovation is a little more incremental than I would like. My number one challenge is to break through some cultural barriers and improve the pace of innovation—to take, frankly, a little more risk and bring NASA back to being a cutting edge agency, as it was in the 1960s. The capability is within us. We just have to pull it out and get motivated.

The second challenge is budgetary and external. It is about building our relationships with Congress. If we're talking about technology development, we're not talking about something that's going to be produced tomorrow. We're talking about visions of the future. What's NASA going to be like a decade from now? What are we going to be doing in aeronautics or in space two decades from now? That is a very interesting challenge for Congress to wrestle with, so there's much communication and relationship building needed there.

I'd say the third biggest challenge is prioritization and selection from the many wonderful ideas that have been flowing into my office. There are a tremendous number of great ideas and many of them will influence NASA's future missions—not just NASA's missions, but the missions of other government agencies, and society as well. It is a great challenge to sort through all that data and to prioritize with the limited funding we have. We need to select just the right portfolio of technological investments for our future.

## On the New Space Technology Program

NASA's Space Technology Program is going to be managed within three divisions. The first division, the Early Stage Innovation Division, is going to focus on the revolutionary ideas that could impact NASA in 10, 20, or 30 years. What we'll be looking for in these programs are people's visions of the future. We'll be making those awards in a competitive manner. These will be relatively small, dollar-value awards.


They'll be made to organizations that could include people in the government, academia, and industry. Frankly, we're looking for the best ideas, wherever those ideas may come from. I fully expect America's universities to be involved in this program. I think small business will certainly play a large role here. I think our government labs will have a big role in early stage innovation.

The Game Changing Division, the second division, is very important. It is the piece that has been missing. In the past, we've done a lot of systems analysis and concept work, but we've been missing the program that takes those innovative ideas and proves them in our laboratories, in ground-based testing. This division is specifically built upon the lessons learned from DARPA, ARPA–E, and the Intelligence Advanced Research Projects Activity (IARPA).

Disruptive technology is a technology that fundamentally changes the way NASA goes about its business. The Exploration Systems Mission Directorate (ESMD) has a roadmap for how human explorers are going to go out beyond the Earth's orbit. It is a plan based on a single set of technologies. What we want to do through the Game Changing Program is to disrupt ESMD's plans. We want to infuse new technology into that plan. We want that technology to be mature enough so it can be baselined into ESMD's plans to send humans out to an asteroid or to Mars.

These kinds of disruptive innovations occur around us all the time. The cell phone is a great example. I think we all have them, but 10 or 15 years ago, very few of us did. It has revolutionized the way we communicate. It has changed

the game. While the cell phone is an example right here on Earth, there are a number of disruptive technologies that one can envision for space exploration or aeronautics as well.

The third division in the Space Technology Program is the Crosscutting Capability Demonstration Division. This division focuses on the maturation of a small number of technologies to flight readiness. It's great to have a program where we're doing ground-based testing and laboratory testing, but our missions are still not willing to fly that technology until it's been demonstrated in a relevant space environment. Within the division, we're going to use sounding rockets and atmospheric flight testing to prove a small set of technologies. It's a little more expensive, but these demonstrations will be very important. We're going to pursue these demonstrations hand-in-hand with our Mission Directorates, so that we have an infusion path for that technology.

## On Addressing Grand Challenges

Starting with NASA's strategic plan, we've been defining a set of grand challenges. We're going to be using these grand challenges to organize the Space Technology Program. In human exploration, perhaps the grandest challenge of them all—at least in my lifetime—will be to send humans to Mars. This is actually something that I know a little bit about. I've been working on it for quite a few years. Frankly, we can't do it with the existing technology. There are a number of breakthroughs that are needed to have humans walk on the surface of Mars.

I've been involved in the design of some of the robotic missions that have gone to Mars. Robotics is a great challenge in itself. However, it's one thing to land a spacecraft the size of this table on the surface of Mars; and it's quite another thing to land a two-story house, right next to perhaps

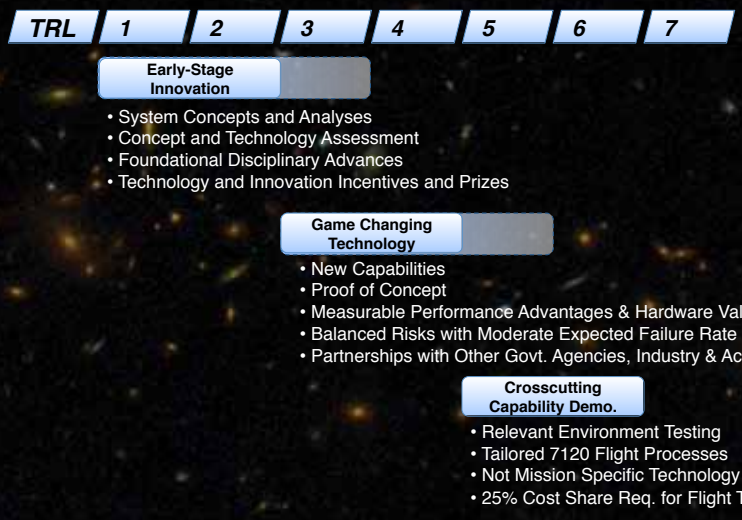
## NASA's Space Technology Program Mission

### GUIDING PRINCIPLES

- Advance broadly-applicable technology.
- Produce technology products for which there are multiple customers.
- Meet the nation's needs for new technologies to support future NASA missions in science and exploration.
- Employ a portfolio approach over the entire technology readiness level spectrum.
- Competitively sponsor research in academia, industry, and the NASA Centers based on the quality of the research proposed.
- Leverage the technology investments of our international, other government agency, academic, and industrial partners.
- Result in new inventions, new capabilities, and the creation of a pipeline of innovators trained to serve future national needs.

### PROGRAM ELEMENTS

- **Early-Stage Innovation:** Creative ideas regarding future NASA systems and/or solutions to national needs. Includes Space Technology Graduate Fellowship program.
- **Game Changing Technology:** Prove feasibility of novel, early-stage idea that has potential to revolutionize a future NASA mission and/or fulfill national needs.
- **Crosscutting Capability Demonstration:** Maturation to flight readiness of cross-cutting capabilities that advance multiple future space missions, including flight test projects where in-space demonstration is needed before the capability can transition to direct mission application.




NASA

"I think to be a good leader today requires the ability to integrate. It's about integrating knowledge from disparate fields, learning from that knowledge, and applying it to new problems." — *Dr. Bobby Braun*

another two-story house with all the fuel and supplies humans might need for their long stay on the surface. The mass requirements or the weight requirements of such a mission are also tremendous. It makes the amazing work that we've done on the International Space Station pale in comparison.

If you look at the Science Mission Directorate, perhaps one of the grand challenges there is the question, "Are we alone?" This is something that I actually think about when I'm on the farm, away from the city. If you look up at the night sky and you see all those stars, you can't help but wonder how many planets are orbiting around those millions of stars, and how many of those planets could be Earth-like? Of those Earth-like planets, how many could be inhabited? I believe that through technology investments, we will develop robotic missions that will go out through our solar system, and one day we'll be able to tell whether there has ever been life on neighboring planets. Without technological investments, these types of things are just not in the cards.

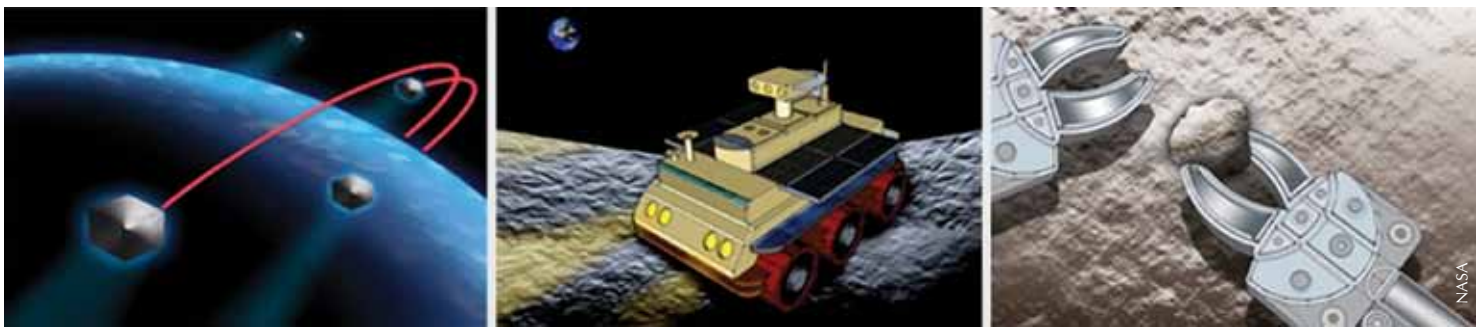
## On the Benefits of NASA's Centennial Challenges Program

Centennial Challenges is a fantastic program. It's a prize competition that lays out grand challenges for the public to go after. These challenges are related to NASA's mission. For instance, there was an astronaut glove challenge that sought improvements in the efficiency and durability of these gloves. When we put out such a challenge, all kinds of people respond—the diversity of the teams is amazing. And NASA doesn't pay any of these teams; they all do it on their expense. They enter the competition and only when they meet the milestone do they receive payment. It's really the spirit of American competition and innovation that drives them.

NASA has been doing this for a few years, but now the rest of the government seems to be interested. The White House recently issued a policy paper stating that more of the government should get involved in challenge programs. They actually cited NASA and the Centennial Challenges Program as a model for what the other government agencies could be doing.

## On Leadership

On the one hand, technology is making things simpler for us, but the pace of innovation and the pace of our communications and relationships are getting faster and faster. I think to be a good leader today requires the ability to integrate. It's about integrating knowledge from disparate fields, learning from that knowledge, and applying it to new problems. It's




Three new prize challenges were announced on July 13 at the Industry Forum for the NASA Office of the Chief Technologist. These are the first new challenges since 2005. From Left to Right: **The Nano-Satellite Launch Challenge:** to place a small satellite into Earth orbit, twice in one week. The prize purse is $2 million. **The Night Rover Challenge:** to demonstrate a solar-powered exploration vehicle that can operate in darkness using its own stored energy. The prize purse is $1.5 million. **The Sample Return Robot Challenge:** to demonstrate a robot that can locate and retrieve geologic samples from a wide and varied terrain without human control. The prize purse is $1.5 million.

about developing new products and new markets for those products. Those are the things that I'm focused on, and that I have been focused on throughout my career.

First, we need a clear focus on what's important. Why are we doing technology innovation? In my view, we're not doing it just to go play in the sandbox and see what kind of gadgets we can develop. We want to invest in technology at NASA because it will enable much grander missions in the future. It will enable us to explore with robotic precursors, and ultimately with humans in space, at a much faster scale and in a more sustainable manner.

Secondly, we need a stability of purpose and stability in the budget. We need consistency in our direction. We can't be moving in a certain direction in technology this year and then have a dramatic shift next year. We are making long-term investments and they take a few years to come to fruition. The only way we're going to get these disruptive and emergent technologies into our space program is through a portfolio approach, in which we make a wide variety of investments. Some of them will grow into amazing technological solutions for our future, and some will not.

We also need to have strong project management skills and expertise to be successful. It's about nourishing and nurturing investments that are flourishing and terminating those that are not. That has proven to be a challenge throughout government programs in the past. We are setting up the new Space Technology Program that way and we have Congressional backing.

## On Cultivating a Risk Tolerant Environment

This is incredibly important to what we're doing. What does acceptable risk mean to a technology development program? This is part of the cultural challenge I mentioned. We need to have a tiered-risk acceptance approach in NASA. Certainly, in our human space flight programs, we need to take every precaution and prioritize safety. Failure is not an option for human space flight. We probably don't want to take a lot of risk on a multi-billion-dollar scale, single-launch mission. However, as we go to smaller missions and move into technology development, we certainly need to take more risks. Unless we take risks, we won't be developing game changing innovations.

The only way I know to innovate is to take risks. The only way I know to make progress toward a grand challenge or develop a game changing technology is to take risks. With risk comes a higher probability of failure. With the Space Technology Program, we're saying straight up that we are


going to fail. What's important is that when we fail, we fail forward and learn from that experience. When we succeed, we succeed in such a manner that a disruptive technology comes in and we skip a couple of steps along the way. That's the model that we're shooting for, and it will only occur if we take some risks.

## On Advice to Future Leaders

First, I'd say go to school. Second, do something in your career that you're passionate about. I don't care whether you work on the next airplane, automobile, or an improvement to the cell phone—do something that you're passionate about. Too often in our country we talk about money and we push people into career directions for financial reasons. I really believe that you need to be passionate about your work and about your career. Third, help to build the future. In my case, I want to build the future through technological innovations and solutions, and do so with an eye towards changing the world. If we want to, we can all change the world. We just have to try. ◘

To learn more about NASA and its Office of Chief Technologist, go to http://www.nasa.gov/offices/oct/home/index.html

To hear *The Business of Government Hour's* interview with Dr. Bobby Braun, go to the Center's website at www.businessofgovernment.org.

To download the show as a podcast on your computer or MP3 player, from the Center's website at www.businessofgovernment.org, right click on an audio segment, select Save Target As, and save the file.

To read the full transcript of *The Business of Government Hour's* interview with Dr. Bobby Braun, visit the Center's website at www.businessofgovernment.org.