

**Remarks as delivered by The Honorable Shana Dale  
NASA Deputy Administrator  
Boston Future Forum  
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Thank you very much. I would like to especially thank Dr. Yannis Miaoulis and the Museum of Science for being such wonderful hosts and to express NASA's appreciation to our sponsors and key partners. It is an honor to be here today at one of the top science centers in the Nation for the sixth of our seven Future Forums. In this month's issue of Parents magazine, the Museum of Science was ranked number three in the country and is the most visited cultural institution in New England. Clearly, the Museum of Science is very successful in meeting its mission to "stimulate interest in and further understanding of science and technology and their importance for individuals and for society."

Through inspiration, innovation, and discovery NASA continues to meet its mission to explore. This year, we're celebrating NASA's 50th anniversary. During the last five decades, we've made amazing achievements in space; we've seen complete hurricanes for the first time; we've stepped on to the surface of the Moon; and we've seen to the far reaches of the universe. We've discovered evidence of dark matter and dark energy, and with that, realized that we have seen only a tiny fraction of what is actually out there. Yet, there is another side of NASA – a critical part of our story, which does not often receive the accolades or attention given to our exciting missions and discoveries.

### **SPACE ECONOMY**

This other side of NASA contributes to what we call the "Space Economy" – the very tangible and pervasive ways in which the exploration of space affects our daily lives here on Earth. The Space Economy is the full range of activities that create and provide value to human beings in the course of exploring, understanding and utilizing space. Space is pervasive in our lives, invisible, yet critical to so many aspects of our daily activities and well-being. When we use our GPS units to keep us from getting lost, withdraw cash from an ATM, or listen to satellite radio, we experience the benefits of the Space Economy. Today's Future Forum is about how NASA and the Space Economy contribute to your community.

Space exploration has created new markets and new technologies that have spurred our economy and have changed our lives in many ways. According to a 2008 U.S. Space Foundation report, the Space Economy generated more than \$251 billion in total revenues worldwide, up 11 percent from the previous year. So what does this have to do with NASA? Our mission is not to create commercial products or to stimulate the economy, although our work has often had those effects. Our focus is not on healthcare or medical research for the general public, yet we have made significant contributions in those areas. We are not the Nation's environmental agency, yet we provide critical information that advances environmental understanding.

The simple answer is that exploration of space demands that we push the limits of knowledge, science, and technology in ways that we could not have originally imagined – and the benefits go far beyond our space exploration mission. NASA contributes to the Space Economy through the three principal topics we will discuss today: Inspiration, Innovation and Discovery.

### **INSPIRATION**

Let's face it. It all begins with education, and because space exploration is so exciting and so cool, it inspires kids to go into science, engineering and math. Generations of students have been inspired to pursue these studies for a glimpse into the mysteries of our universe. Over the last 50 years, many of these students have gone on to power every form of innovation from advancing the development of the computer chip to mapping the human genome. Maintaining our Nation's leadership role in the global economy requires that we encourage more American students to focus on these fields. Using the inspirational pursuit of space exploration

to spark the imagination of our youth is critical for keeping this Nation competitive and creating a scientifically literate populace.

The Museum of Science provides engineering curricula for elementary, secondary and high-school students and is helping to spark the imagination of our Nation's youth in over 30 states. The goal is to share the curricula in all 50 states by 2015. The Museum is also the home of the National Center for Technology Literacy. These programs are helping us meet our common goal of keeping science and technology at the forefront and inspiring students to go into these fields. I look forward to a solid discussion today on how best to inspire the next generation of innovators and scientists.

## **INNOVATION**

Inspiration leads directly to innovation. NASA drives innovation by tackling hard, complex problems and by overcoming seemingly insurmountable obstacles. Because our mission demands putting humans, robots and rovers into harsh, extreme, and unforgiving environments, we must push the very limits of technology. This is often where we realize the greatest innovations.

For instance, A space-derived technology that is making a difference here and abroad is a robot created for Mars exploration. Helen Greiner, who I believe is here today, founded iRobot, the company that further developed the technology into a tactical reconnaissance robot. These robots are saving the lives of our service men and women. Our U.S. troops use these robots in Afghanistan and Iraq to clear caves and bunkers, to cross minefields and to deal with the dangers of improvised explosive devices.

According to iRobot, soldiers have given their robots nicknames. The Washington Post has reported that the robots' military keepers have become so attached that they have even awarded the robots with unofficial "purple hearts" and "battlefield promotions." While this technology is not a highly visible achievement of America's space program, it is critically important. And it represents only one of over 1,600 documented NASA-derived technologies that fuel local economies and strengthen U.S. economic competitiveness. And, after these technologies are further developed they are often used again by NASA for "spin in" applications. Such applications, occur when innovations come full circle, and technologies that have spun-out of the Agency are further refined and then infused back into NASA. An example is a robust, flexible form of insulation created for space shuttle launch applications.

Aerogel is the world's lightest solid and has amazing, unsurpassed thermal insulation values. It is, however, extremely fragile and very costly. Through a Small Business Innovation Research contract, NASA worked with Aspen Aerogels Inc., of Northborough, Massachusetts, to make the initial aerogel insulation easier to use and more cost-effective. The company further developed the material for commercial use and now, aerogel can be used as a standard insulation. Aspen products are found in industrial, commercial and residential applications. Providing maximum thermal protection, aerogel is even used in extreme weather gear for explorers climbing Mt. Everest, and ultramarathoners, who find aerogel to be efficient for its light weight and heat-insulating properties. For NASA, We are looking at ways to use the insulating Aspen aerogel including space shuttle applications, interplanetary propulsion and life support equipment.

NASA-derived technologies are also directly improving the living conditions of people in the eveloping world. The water recycling and filtration systems engineered to sustain astronauts living on the International Space Station have been adapted to provide safe, affordable drinking water in poor or remote regions of the world where clean water can mean the difference between life and death.

These are only a few examples of what NASA technologies mean for all of us here on Earth, but, it is by no means an exhaustive list. The point is that technology advancement doesn't recognize boundaries. The same capabilities that apply "out there" in space also apply directly to our most critical needs back here on Earth. Those advances are then refined, adapted, or transformed to meet the challenges we face from improving residential insulation to providing clean drinking water to protecting our soldiers and Marines.

These contributions also benefit Boston and the entire State of Massachusetts. In FY 2007, NASA obligated over \$173 million in the state. This funding went to business, education, and non-profit institutions. Massachusetts is also playing an important role in building the next-generation spacecraft for the Constellation program – the program that will enable us to return to the Moon and then go to Mars and beyond. Spincraft Inc., in North Billerica is working on the Ares I Launch Vehicle’s Upper Stage J-2X engine. These investments, as well as our efforts in areas such as Earth and space science and fundamental aeronautics research, are helping our high tech industries stay on the cutting edge of competitiveness and thereby driving U.S. economic growth.

NASA’s investments driving these innovations are happening on a budget with a funding level that is less than six-tenths of one percent of the federal budget. With this budget, we invest in and accomplish amazing missions – such as: embarking on the human journey back to the Moon for a mission that is vastly different from Apollo. About twelve years from now, we’ll live on the surface of that world, and learn enough to take the next steps out into our solar system using NASA satellites to observe remarkable changes in the environment, such as the rise of global sea level, the depletion of sea ice and glaciers, and the increase in transcontinental transport of air pollution; conducting fundamental research in aeronautics that will lead to quieter, safer and more efficient airplanes; expanding our knowledge about the universe and our place in it, through projects like the Hubble Space Telescope; and leading the largest international cooperative endeavor in the history of science and technology – the International Space Station.

## **DISCOVERY**

From innovation, NASA opens the door to new discoveries. NASA’s pursuit of discovery pushes the extremes of science to answer fundamental questions, to achieve a greater understanding of the universe, and to determine what is happening to the Earth’s climate and why. In space exploration, we are in an exciting new age of discovery, going to the Moon, Mars, and beyond. In cooperation with our international partners, we’ll construct an outpost there, a sustained human presence on the Moon. NASA is pursuing discoveries that will enable us to accomplish this endeavor. To survive on the Moon’s surface, we must find ways to create, collect, store and use energy without access to fossil fuels. Other sources of energy must be developed into practical resources that humans can use in extreme environments.

As we continue to explore new sources of energy and new delivery methods, these efforts can help to address the pressing demand for energy right here on Earth. Space exploration demands cleaner and more efficient sources of energy that can operate in extreme environments without toxic effects. The potential impact of alternative, clean energy sources is so great, that we can hardly imagine it, affecting the lives of not only Americans but of every person on the planet. Outposts on the Moon, as well as travel to Mars, will require lighter materials, manufacturing techniques with little waste or pollution, and even better methods of recycling and reuse, this will contribute to the development of sustainable systems in our own world. That’s what will happen in the future, but what is happening now?

How is NASA’s work, right now, contributing to the sustainability of our planet? In space travel, physical space is limited, weight is critical, and resources are severely constrained. Every watt of energy is accounted for; every resource is transported and monitored. Space exploration drives the development of technologies with minimal impact to these tiny ecologies – and, by extension, o the ecology of Planet Earth. These technologies include advanced recycling techniques; treating waste and converting it back into usable resources, as well as new, green power systems.

But, perhaps NASA’s biggest contribution to sustainability is improved understanding of the global integrated Earth system through observations from a constellation of fifteen Earth-observing satellites and cutting-edge global models. NASA satellites record more global climate change data than those of any other organization in the world. It is only through NASA’s investments in measuring the forces and effects of climate

change that we have insights into the future conditions of Earth's changing environment and understand its implications to our home planet.

In September 2007, NASA scientists observed the smallest Arctic sea ice coverage ever recorded. And this effect is accelerating. The sea ice coverage in September 2007 was smaller than in September 2006 by an area that exceeded the combined geographical areas of California and Texas. Based on NASA satellite data, we see the ice sheets of Greenland and Antarctica melting more rapidly than predicted. For each of the past four years, the amount of ice in Greenland has decreased by more than twice the amount of ice in the European Alps. This huge amount of ice is melting and flowing into the ocean. The melting of Greenland ice has increased the global sea level by 0.5 millimeters per year.

Using NASA satellites, we have recorded rising global sea levels in excess of 3.2 millimeters per year over the past fifteen years, with approximately one-half of that increase due to melting of the Greenland and Antarctic ice sheets and mountain glaciers. The other contribution to global sea level rise is the thermal expansion of the oceans as the oceans absorb heat from the atmosphere.

In regards to nitrogen oxide emissions, one of the greenhouse gases that form smog, NASA satellites helped researchers document their doubling in Asia from 2000 to 2006. This incredibly important climate data is discovered through NASA's fifteen Earth-observing satellites in orbit today. And we have another six Earth science missions in development, three of which will launch over the next 20 months. And this year we initiated formulation and concept study activities for four Decadal Survey missions, expected to lead to the first satellite launch in this new program as early as 2013. All in all, NASA invests approximately \$1.3 billion every year in Earth Science. As we continue to explore, we're making new discoveries along the way that are helping our planet.

## **CONCLUSION**

Inspiration, innovation and discovery: each is interdependent and through a circle of renewal, they combine to create a formula for future growth, prosperity and an improved quality of life. This symbiotic relationship forms the essence of the Space Economy and it is through inspiration, innovation, and discovery that NASA makes its most fundamental contributions to life here on Earth. Space exploration is about imagining the future. It's about taking new steps, exploring beyond our limitations, creating something bigger and better than ourselves. Along the way, there are countless benefits, invaluable discoveries, and technologies borne through the trials of exploration that enhance our lives on Earth. That's been true for NASA's first fifty years. And I have no doubt that it will be true for the next fifty years.

Quests of discovery are as old as humanity itself. We go to see what is beyond the horizon, to test ourselves against the unknown, to face our fears and overcome challenges using all of our ingenuity and determination. That's the spirit of exploration. And that's why the space program shows us at our best: dreaming, daring, and achieving. I look forward to a day of discussion about the future. A future brightened by the prospect of a growing Space Economy and continued space exploration. And all the promise that holds for the people of Boston, for our nation and for our world.

Thank you.