

Remarks by the Honorable Shana Dale  
NASA Deputy Administrator  
Seattle Future Forum  
January 25, 2008

Thank you all very much. I'd especially like to thank Dr. Bonnie Dunbar, the CEO of the Museum of Flight, and the museum staff for their wonderful support in hosting this event and making it a reality. I've known Bonnie for many years and I have the greatest respect for her accomplishments. Bonnie is a veteran of five space flights including two as Payload Commander; not too many astronauts can claim five space flights. And now she leads one of the largest air and space museums in the world, attracting more than 400,000 visitors annually.

I would also like to extend NASA's appreciation to our sponsors and key partners. They include the Boeing Company, Google, WSA – Washington's Technology Association, the University of Washington, Washington Space Grant Consortium, Raytheon, and the National Institute of Aerospace.

Like many at NASA, being a part of our nation's space program is the fulfillment of a life-long dream for me. I think what attracted all of us at NASA to the space program is the same thing that keeps the American people so intrigued and inspired by our mission: the excitement of discovery, that irresistible human impulse to explore beyond the next horizon, the feeling of being a part of something bigger and grander than ourselves. Ultimately, I believe, that is what motivates this great voyage of discovery.

In my talk today, however, I want to focus on another side of NASA, a critical part of our story that doesn't get as much attention as our exciting missions and discoveries.

I want to talk about what we call the "Space Economy" and the very tangible and pervasive ways in which exploration of space affects our daily lives here on Earth. To put this discussion in context, as we talk about the Space Economy and the promise of the future, we all should recognize that as taxpayers, the portion of the federal budget that goes to NASA is probably

smaller than many of you might expect, only six-tenths of one per cent, with which NASA performs all of its spectacular missions.

First, we need to define the Space Economy. With some help from experts, we define it as 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. In fact, the Space Economy impacts just about every aspect of how we live, work, and play, including weather and climate monitoring and space-based security applications that keep us safe. When we pay for gas at the pump, draw cash from an ATM, or enjoy listening to satellite radio we can experience the benefits of the Space Economy.

Space exploration has created new markets and new technologies that have powered our economy and changed our lives in many ways. Today, according to a U.S. Space Foundation report, the Space Economy generates over \$200 billion in total revenues worldwide, with the promise of new exciting markets including a nascent space tourism industry and the development of space logistics services that will further transform space into an even more robust commercial enterprise. So, while the commercialization of space for new emerging markets is just around the corner, the Space Economy has already arrived and is thriving.

So what does this have to do with NASA? And how does NASA contribute to the Space Economy?

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, technology and precision in ways that we could not have originally imagined and the benefits go far beyond our space exploration mission.

NASA's contributions to the Space Economy are through the three principal topics we will be discussing today: Inspiration, Innovation and Discovery.

The space exploration mission is one that is unique in its ability to inspire the public. Who can witness a Shuttle launch or the view from a rover on Mars and not feel a sense of awe? Generations of students have been inspired to pursue studies in science, engineering and math with the goal of getting a glimpse into the mysteries of our universe and understanding the mechanics of spaceflight. Over the last fifty years, many of those students went on to power every form of innovation from developing the computer chip to mapping the human genome.

NASA drives innovation by tackling hard, complex problems and overcoming seemingly insurmountable obstacles. Since our mission demands putting humans and robots into harsh, extreme environments, we must reach into the unknown to achieve our goals. This is where we are challenged to push the very limits of technology and where we realize the greatest innovations.

NASA's pursuit of discovery pushes the extremes of science to answer fundamental questions about who we are and where we come from; to achieve a greater understanding of the universe; and to determine what is happening to the Earth's climate and why. These discoveries, whether it is the discovery of how the first stars formed, the history of water on Mars, or uncovering the mysteries of space weather, serve to whet the appetite of future generations and inspire them to push further the ever-expanding frontiers of human understanding.

Inspiration, innovation and discovery: each is interdependent and through a virtuous circle of renewal they combine to create a formula for future growth, prosperity and an improved quality of life. These form the essence of the Space Economy and it is through them that NASA makes its most fundamental contributions to life here on Earth.

This year we're celebrating NASA's 50<sup>th</sup> anniversary. And for 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 all we can see is a tiny fraction of what is actually out there.

This forum is dedicated to celebrating these and other phenomenal achievements, but it is also to focus our attention on the incredibly exciting

missions of the future. It's about recognizing that we have all benefited from the space program in both direct and subtle ways, and realizing that each of us has the opportunity to be part of humankind's next steps outward. Most importantly, today's Future Forum is about how NASA and the Space Economy contribute to your community.

Through inspiration, innovation and discovery we're building bridges towards a stronger, more competitive economy, a more sustainable environment and an improved quality of life for us all to enjoy. Let me expand a bit on the importance of these three critical themes and NASA's role in each.

### ***INSPIRATION***

Let's face it. It all begins with education and because space exploration is so exciting and so cool, space exploration inspires kids to go into science and math and engineering.

Maintaining our nation's leadership role in the global economy requires that we encourage more American students to focus on these fields. We know from example after example of today's science and technology leaders that for many, their road to greatness began when they first looked up at the stars. 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.

It's also essential to your economy right here in Seattle. Success in space starts in the classroom. That's why we're investing significant resources in education. For instance, we support the Washington NASA Space Grant Consortium, which was one of the first Space Grant Consortia in the United States, as it reaches students and educators at all levels.

We bring space to students in other ways too. For instance, during the first ten expeditions to the International Space Station, astronauts interacted with almost a million students via live video conferences. Last year, Barbara Morgan became our first teacher turned astronaut in space. I hope some of your kids will follow her into space.

Our current venue, the Museum of Flight, has developed education programs that are inspiring the next generation of explorers. Over 80,000 school-age children participate in programs aligned with state and national education standards. NASA is pleased to cooperate with the Museum of Flight on the Washington Aerospace Scholars program. The effort is an educational program for high school juniors from across Washington State emphasizing science, technology, engineering and math, and encouraging students to consider careers in these fields. NASA has designed the online curriculum associated with the program. And thanks to the Washington Aerospace Scholars Foundation, the entire program is offered at no cost to participants. The Museum of Flight hosts a week-long summer residency experience for the scholars during which they are guided by professional engineers and educators as they design a human mission to Mars.

For NASA, for the nation and for communities such as Seattle, inspiring students to pursue science, engineering and math fields is critical to economic growth and global competitiveness. I look forward to a solid discussion today on how best to build the next generation of innovators and scientists.

## ***INNOVATION***

That leads me to innovation. NASA helps drive U.S. innovation that, in turn, builds our economy. We tackle hard, complex problems in the harsh, remote and unforgiving environment of space.

Doing so produces real achievements like assembling the enormous components of the nearly 500 metric ton International Space Station, and just recently, sending our MESSENGER spacecraft hurtling past Mercury and exploring it for the first time in over 30 years. But there are less visible achievements as well, like creating the key technological breakthroughs that fuel local economies and keep our nation competitive.

Many of you may have heard of NASA spin-offs: specific technologies the agency has developed for its missions that the private sector has then picked up and refined or transformed for commercial use. There are over 1,500 documented NASA-derived technologies, ranging from better cancer

detection methods to robots that clear caves and cross minefields in Iraq and Afghanistan in advance of our soldiers and marines.

I'll talk more about those invisible essentials in a moment. But my first point is that they, like the visible essentials of space – rockets and satellites – are all part of the Space Economy.

The Space Economy consists of space-related products and services, as well as the new markets and possibilities for economic growth that space exploration encourages. The Space Economy is emerging, growing, and already very valuable. As I noted earlier, the Space Foundation's most recent report (Space Report 2007) estimated that the global space industry produced nearly \$220 billion in total revenues in 2006, up nearly 20 percent from the year before. That's an incredible rate of growth.

In its report, "The Space Economy at a Glance 2007," the international Organization for Economic Co-operation and Development (OECD) pointed out that, "The many derived space-based services have positive impacts on economies and societies." For instance, early semiconductor companies were challenged by the Apollo program to develop integrated circuits that met stringent quality and performance requirements – they had to be smaller and more powerful than ever before. That straightforward technical requirement was catalytic, starting a cascade of developments which has led to countless new products and entirely new markets. Today the phone booth has gone the way of snail mail: We simply send e-mails, or use our cell phones to call our friends around the world. Satellites have made that near-instantaneous information sharing possible, creating global networks of friends and trading partners, as well as improved climate monitoring and better weather forecasting.

### ***SPACE-DERIVED TECHNOLOGIES***

NASA innovations also show up at the doctor's office. For instance, algorithms developed to analyze images from Mars have been adapted to an advanced diagnostic tool for heart disease that can detect arterial blockage earlier and more effectively than other techniques. The best part is that scalpels are not needed, and the patient is not exposed unnecessarily to radiation, since the new tool is non-invasive.

In the 1990s, NASA invented a device called a bioreactor that today helps the National Institute of Child Health and Human Development of the National Institutes of Health and hundreds of laboratories around the world to culture cells in new ways. That bioreactor has enabled new, promising venues of cancer research, and has led to more than 25 patents.

NASA's work has contributed to other advances in cancer detection and treatment. Breast biopsies are critical for the detection and treatment of breast cancers. And thanks to high resolution, real time imaging technology derived from the Hubble Space Telescope program, breast biopsies can be performed with a needle instead of a scalpel. The needle biopsies leave only a small mark instead of a large scar, cost significantly less than traditional biopsies, and can be performed in a doctor's office as opposed to an operating room.

Critically-ill heart patients waiting for heart transplants are now being kept alive by implanted heart pumps developed by engineers from the Johnson Space Center in Texas and supercomputer experts from the Ames Research Center in Mountain View, California. The team analyzed blood flow through the heart pump using the same methodologies we've been employing to analyze fuel and oxidizer flow through rocket engines. To date, more than 400 of these extraordinary heart pumps have been implanted in people worldwide, giving them a second chance at life.

NASA-driven innovations have also improved LASIK eye surgery. The eye is constantly moving and doesn't stop during surgery. So eye tracking devices must be able to fix the eye's position at least 1,000 times per second if surgery is to be safe. Today, many eye surgeons across the country are using a system, developed in partnership with the Johnson Space Center, based on laser technology developed to enable unmanned space vehicles to dock with and service satellites in orbit.

NASA-derived technologies do more than return people to health. They prevent them from getting hurt in the first place. That's made a difference in high-hazard areas like battlefields. For instance, a robot created at the Jet Propulsion Laboratory in California for Mars exploration has been further developed into a tactical reconnaissance robot. U.S. troops are using those robots in Afghanistan and Iraq to clear caves and bunkers, as well as to cross minefields and to deal with the dangers of improvised explosive devices.

Such robots have saved lives. According to iRobot, the company that makes them, soldiers have given their robots nicknames. According to the *Washington Post*, the robots' military keepers become so attached that they have even awarded the robots with unofficial "purple hearts" and "battlefield promotions."

And there is more in regards to international affairs. There are the ongoing concerns about the condition of people in the developing world. And here again, NASA-derived technologies come into play. 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 and remote regions where clean water can mean the difference between life and death.

NASA technologies can help ensure that water gets where it is most needed in other ways as well. When terrible blazes raged across Southern California last fall, NASA's Earth-observing satellites helped monitor their spread. We also sent an unmanned aerial vehicle equipped with thermal-infrared sensors and sophisticated real-time transmission equipment over the fires. The unmanned Ikhana drone peered through heavy smoke and darkness and found hot spots and flames. It then transmitted the information to the National Interagency Fire Center which distributed the imagery to fire incident commanders over the Internet. These commanders were able to use this information from NASA and deploy firefighters real-time to the most vital locations.

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 and transformed to meet the challenges we face, from heart pumps to advanced breast cancer imaging to compact water filtration systems.

They also benefit Seattle, and the State of Washington, in real ways. Over the past five fiscal years, NASA has invested well over \$100 million in the state of Washington. Last year (FY 07), more than \$17 million went to Washington businesses and nearly \$9 million to state educational institutions like the University of Washington. Large companies like Boeing benefited

from those investments, but smaller ones did too, including: Andrews Space Inc.; Beck Engineering, Inc.; and Sequoia Scientific, Inc.

These investments and innovations – as well as the Space Shuttle program, the International Space Station, future human explorations, aeronautics research, and all of our science endeavors – are happening on a budget with a funding level that is less than six-tenths of one per cent of the federal budget. Through those investments, we are:

- 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;
- Observing our Earth from the unique vantage point of space, which is essential for climate change research and disaster response and mitigation;
- 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.

Because of these efforts, NASA is helping our high tech industries, a major force in U.S. economic growth, stay on the cutting edge of competitiveness.

## ***DISCOVERY***

Through innovation, NASA opens the door to new discoveries. We have discovered a great deal through NASA's research into lightweight composite materials, quieter and cleaner aircraft engine technologies, and advanced air traffic management tools. These are all making air travel safer, more efficient and more environmentally friendly.

Our aeronautics research program has contributed to innovations like winglets, which are vertical extensions of wingtips that improve an aircraft's fuel efficiency, cruising range, as well as the space required at the airport. They're being used around the world, on all types of aircraft. A more recent NASA/industry research collaboration resulted in a new engine nozzle design, which reduces engine noise.

In space exploration, we in an exciting new age of discovery, going to the Moon, Mars, and beyond. Unlike an earlier era, we're going back to the Moon to stay. In cooperation with our international partners, we'll construct an outpost there, a sustained human presence on the Moon.

Let me emphasize those words "sustained human presence." The outpost on the Moon will be a toehold to further exploration, a place where we will stay for long periods of time and learn how to live and work and conduct science far from home. We'll learn to live off the land at this outpost, using the Moon's abundant resources near its South Pole region to strive for a self-sustaining operation.

Critical to that enterprise will be water – as a vital source for life support oxygen, and for power and rocket fuel after it is broken down into its constituent elements of hydrogen and oxygen. Even if we don't find "water" in its frozen state, there are high concentrations of hydrogen and oxygen. Hydrogen extracted from the lunar soil can be used in fuels or combined with oxygen to create water.

Believe it or not, the outpost on the Moon also has significant potential for improving human health. Sustained settlement on the Moon will mean surmounting a whole new list of medical challenges. Despite care and planning, accidents can and will happen during extended stays in space. So those living in the lunar outpost will need new ways to treat injuries and illnesses, like diagnosis at a distance and telemedicine. They may even need new, "smart" medical devices, since no space mission is likely to have a full staff of medical specialists aboard. This need will be even more acute for the Mars mission, which will require months in space, and could be nearly three years – 1000 days – in total duration.

The lunar outpost may also require new abilities to detect and eliminate disease-causing microbes and toxins in the environment and to extend the

shelf-life of medicines. The specific advances that could come from these areas are unknown, but their benefits to human health will be real.

And we are planning on making those missions happen. Under the Constellation program, work has begun on the spacecraft that will take us to the Moon and beyond: the Ares rockets and the Orion Crew Exploration Vehicle. Components for those craft are coming together: They are going from blueprints - to models - to tests. People all across the country are working on the program, and many more are likely to have a part. We'll hear more about the Constellation Program later this morning.

Meanwhile, as NASA's robotic probes continue to investigate the fascinating planets and moons of our solar system, others are peering down to monitor the health of our planet. I talked about NASA-driven innovations earlier. Now I'd like to talk about how NASA-derived discovery leads to sustainability of our planet and its natural resources.

Sustainability of our Earth permeates NASA's missions. For example, 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 the means to deliver it 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.

One example of a new and relatively clean energy source offering tremendous potential is solar power. NASA pioneered the use of solar cells in the Apollo Program and continues to push the limits of this technology today, with the solar "wings" that collect the sun's energy for use onboard the International Space Station. Technologies for beaming solar power – moving it from collectors in one place to a remote destination where it may be stored or transferred – hold the promise of a clean and abundant energy source, one that is virtually limitless for as long as the sun endures. The potential impact of these technologies, already being explored by NASA, is so great that we can hardly imagine it, affecting the lives of not only Americans but of every person on the face of the planet.

In addition to renewable energy sources, space exploration contributes to sustainability in many other ways. In space travel, physical space is limited, weight is critical, and resources are severely constrained. Every watt of energy is accounted for; every cubic liter of air is transported and monitored. Space exploration drives the development of technologies with minimal impact to these tiny ecologies – and, by extension, to 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. 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, contributing to the development of sustainable systems on our own world.

But perhaps NASA's biggest contribution to sustainability is the development and operation of Earth-observing satellites. Fourteen of those research satellites that peer down on the Earth are in orbit today. These satellites make countless contributions to the understanding of our home planet. They warn us of gathering storms, approaching hurricanes, and shrinking snowcaps. They provide essential information critical to helping us understand our changing environment, showing pollution from factories, and even increasing the productivity of farmers. And we're not done: Another seven Earth science missions are under development at NASA, three of which will launch this year. All in all, NASA invests about \$1.5 billion every year in Earth Science.

## *CONCLUSION*

In coming here to Seattle I am reminded that 46 years ago, while on Easter vacation in Florida, President John F. Kennedy opened the Seattle World's Fair, otherwise known as Century 21, by using a telegraph key to trigger a radio telescope in Maine, which picked up an impulse from a star 10,000 light years away. This impulse was directed toward the fairgrounds to start the festivities, centered around the futuristic Space Needle, which symbolized humanity's first great exploration leap into the universe.

Today, the Emerald city on the Sound remains one of America's great engines of progress with its thriving aerospace and computer industries.

You in Seattle are helping NASA build the space economy, and creating a better world.

Space exploration is all about inspiration, innovation, and discovery. It's about imagining the future. It's about taking new steps, and exploring beyond our limitations, and creating something bigger and grander 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 in the next five decades.

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 the challenges using all of our ingenuity and determination.

We will continue our quest for new discoveries through the James Webb Space Telescope which will find the first galaxies that formed in the early Universe, connecting the Big Bang to our own Milky Way Galaxy. We will pursue our aeronautics research program to make our air transportation system safer, cleaner, and more efficient. We will establish a sustained human presence on the Moon, place the first footprints on Mars, and then go even further.

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 this holds for the people of Seattle, for our nation and for the world.

Thank you.