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Future of NASA

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The Testimony of
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Mr. Chairman and Members of the Committee, I appreciate the opportunity to appear before the Committee today to discuss NASA's vision for the future of space exploration. As the NASA team works hard to return the Space Shuttle to flight and to resume assembly of the International Space Station, it is important that we not lose sight of where the Nation's space exploration efforts are headed over the long-term. History shows that space exploration endeavors span multiple decades. The decisions that led to the development of the Space Shuttle were made 30 years ago in the early 1970s. Similarly, the decision to initiate the Space Station program was made almost 20 years ago in the mid-1980s. We can expect that decisions made today will guide where and how we venture into the cosmos for decades to come.

That is why I so strongly welcome the opportunity to elaborate on NASA's Strategic Plan for future space research and exploration. While meeting the challenges of today, it is critically important that we not lose sight of the opportunities of tomorrow.

As members of the Committee know, we recently solicited input from Members of the Committee and continue to welcome your ideas. As the exploration vision is developed, the priority, timing, and specifics of some existing programs may change. We will continue to work with Members of this Committee to ensure that the programs pursued are directly aligned with the vision.

In February 2003, NASA released the Agency's new Strategic Plan. This important document is the product of extensive senior leadership debate within NASA. It codifies NASA's Vision of improving life here, extending life to there, and finding life beyond which we hope to achieve by advancing our Mission goals of understanding and protecting our home planet, exploring the Universe and searching for life, and inspiring the next generation of explorers. The Strategic Plan sets the framework by which decisions on future NASA activities will be made, lays out a long-term blueprint for future space exploration, and describes the goals that the NASA team is committed to achieving for the American people.

NASA released our Strategic Plan months before the law required, because the Agency is serious about our Vision and Mission and linking our budget priorities to the goals identified in the Strategic Plan. Early release of the Strategic Plan also ensured it was available during Congressional consideration of NASA's FY 2004 budget.

NASA's Vision

The NASA Strategic Plan begins with the NASA Vision. Instead of compiling a list of everything NASA does, the Agency made a conscious decision to develop a short, concise, and compelling vision statement. Thirteen simple, but powerful, words comprise the NASA Vision. It includes only

the most compelling reasons why the Nation invests in aeronautics and space research and articulates how NASA will contribute to America's legacy for future generations.

To improve life here

The first part of NASA's Vision, "To improve life here," encompasses the terrestrial and tangible benefits of NASA research. NASA aeronautics research develops technologies that make air travel safer and more efficient with fewer environmental impacts. NASA's Earth Science research informs decisions on global change by taking advantage of the unique vantage point of space to help scientists develop a comprehensive understanding of the complex interactions between Earth's atmosphere, lands and oceans. The demands of NASA space missions drive technological innovation across a range of industrial and national security sectors. Through space research, scientists are developing new medical devices and approaches to the fight against deadly diseases. These and many other benefits represent the tangible return from investments in NASA research. With NASA's vision achieved, future engineers will look back at the Agency's work and credit America with solving some of the most pressing transportation, environmental, and technological problems of our time.

To extend life to there

The second part of NASA's Vision, "To extend life to there," inherits and expands on the great American tradition of pioneering exploration. As President Bush has so eloquently stated, "This cause of exploration and discovery is not an option we choose; it is a desire written in the human heart." Since the epic voyage of Lewis and Clark, America has shaped the future by pioneering the frontier. From John Glenn's historic flight in 1961 to the twin rovers currently on their way to Mars, NASA has become the modern-day expression of this tradition. NASA pushes the bounds of human experience and delivers new vistas for human activity. In doing so, NASA ensures American leadership on the frontier and into the future, inspires the American public and the world, and motivates the next generation of scientists and engineers. With our vision achieved, future explorers will look back at NASA's work and credit America with pioneering our solar system's frontier.

To find life beyond

The third part of NASA's Vision, "To find life beyond," seeks answers to questions asked by philosophers, theologians, and scientists since the time of the ancient Greeks. What is our place in the universe? It is the part of our vision has undergone the most change in recent years. A little over a decade ago, there was practically no evidence from our science missions and telescopes that habitable worlds existed beyond Earth. Our cosmos appeared to be a beautiful, but desolate, universe. Much has changed over the past decade. Science missions have found evidence for water, a key ingredient of life, on the planet Mars and some moons of Jupiter. Telescopes have found evidence of over 100 planets circling stars beyond our solar system. Scientists have found life thriving in environments on Earth that were previously thought to be barren. Taken together, these lines of investigation indicate that we may be on the verge of finding life beyond Earth within our lifetime or the lifetime of our children. It would be a profound discovery, a watershed event in human history. As President Bush has stated, "We are that part of creation that seeks to understand all creation." With our vision achieved, future researchers will look back at NASA's work and credit America with the greatest scientific discoveries in human history.

NASA's Space Exploration Strategy

The NASA Strategic Plan fundamentally changes our approach to space exploration. We achieved the marvel of the Moon landing, an incredible accomplishment that has shaped much of NASA today, driven by a great external imperative, the Cold War. That imperative drove our Nation to focus on sending humans to a single destination, the Moon, within a fixed timeframe, a decade. Although a great achievement in human history, the Apollo effort was not sustained. If we are to achieve our vision and send human explorers into the solar system, we must have a more flexible and sustainable strategy.

Scientific inquiry and discovery will guide where and how often we go. We hope to go when new capabilities allow us to do so in a sustainable fashion, so that we can return to that destination when needed and move deeper into our solar system in the future. We will use human and robotic teams to explore as we move out into the solar system.

This strategy provides the framework from which decisions about where, when, and how the next steps in human space exploration will be made.

Human and Robotic Teams

A fundamental element of NASA's space exploration strategy is the use of human and robotic teams to advance our exploration objectives. History shows that space exploration can only be comprehensively performed when robots and humans are used together. Each brings unique capabilities. Robots go where it is still too dangerous for astronauts to go, or perform repeatable or predictable tasks for which astronauts are not necessary. This was the role of the robotic Ranger and Surveyor missions to the Moon that preceded the Apollo astronauts. Astronauts, however, bring the incredibly adaptive tool of the human mind to the frontier. Astronauts provide an ability to reason, learn, plan, react, and manipulate in ways that robots cannot. This has been the role of the astronaut missions supporting the Hubble Space Telescope. Similar relationships between humans and robots can be found in deep-sea exploration today and in the history of the Russian space program.

As the Mars Pathfinder mission showed, the growth of the Internet and high-bandwidth communications offer new means for involving the public directly in the experience of exploration. But only astronauts can translate the adventure of exploration for those back on Earth and provide the human element that puts images from other worlds into full context.

Stepping Stones

The second element of NASA's space exploration strategy is our plan to use stepping stones to reach ever outward in our solar system. This acknowledges that there are many desirable destinations for future human and robotic space exploration and many different pathways between these destinations. Stepping stones include both destinations that are likely to be the focus of intense research and investigation, as well as destinations that provide a convenient testing ground for new exploration approaches and capabilities.

Research over the past decade has identified three destinations that appear to be key to the NASA Vision of finding life beyond. These three destinations will likely be the major research focus of future space exploration. They include:

- The planet Mars, once thought to be a dry and barren planet, is now believed to harbor significant quantities of water ice beneath its surface. Evidence from recent science missions indicates that liquid water may have flowed on the surface of Mars in the distant past and may

occasionally erupt onto its surface today. Where there is liquid water, there is the possibility that life may have developed or even still exists. Through the rest of this decade, NASA will be sending seven spacecraft to Mars, including four landings and three rovers. The first two rovers, the twin rovers Spirit and Opportunity, will arrive at Mars next January.

- The moons of Jupiter, including Europa, Ganymede and Callisto, were once thought to be worlds locked in ice. Evidence from our highly successful and recently completed Galileo mission indicates that these worlds likely harbor planet-wide oceans underneath their icy surfaces. Again, where there is liquid water, there is the possibility that life may have developed. We are planning a breakthrough mission, called the Jupiter Icy Moons Orbiter (JIMO), which will undertake an in-depth, three-year investigation of these worlds early next decade, map out their oceans, and understand their potential for life.

- Planets beyond our solar system, include over 100 that have been discovered to date. We plan to launch two space-based telescopes this decade that will likely identify hundreds, and possibly thousands, of additional planets circling other stars. Most will be very large planets not suitable for life, but there is the possibility that we may begin to identify planets that are closer in size to our own Earth. Eventually, we may want to erect highly capable space telescopes at locations above low-Earth orbit, called "libration points," to characterize and image these Earth-sized planets.

Depending on what our robotic and telescopic trailblazers find at these destinations over the next decade-and-a-half, we will be in a position to know where to send much more capable human and robotic teams to undertake extensive research in the years that follow.

Building Blocks

The third element of NASA's space exploration strategy is the use of "building blocks." This acknowledges two key facts. First, a handful of enabling capabilities are necessary to conduct in-depth exploration of our solar system and beyond. Second, it is desirable to develop these capabilities in a flexible way so they can be used to support missions to more than one destination. There are many necessary building blocks for sustainable exploration, including reliable and affordable launch, intelligent robotics, high-bandwidth communications, lightweight materials, and modular and reusable components. But three building blocks that we will likely need for future human exploration are:

- *Crew Transport* Reliable, safe, and affordable transport of astronauts from Earth's surface to destinations in space is a critical component of any future human exploration effort. We are working to determine the best way to replace the Space Shuttle for crew transport to and from the International Space Station, as well as provide key building blocks for transporting crews farther into our solar system.

- *Crew Health* To safely sustain human operations for long periods of time beyond low-Earth orbit, we will need to know how to protect astronauts from the dangers of space flight and ensure they remain productive in various space environments. This research is already being carried out on the International Space Station, which provides the database from which medical countermeasures to the effects of low-gravity can be developed. Other research being carried out on the ground, including radiation research and life support systems research, is also critical to overcoming the limitations of the human body for exploration deep into our solar system.

- *High Energy Power and Propulsion* New capabilities are necessary to overcome the constraints of mass, energy and time that limit our current exploration missions. Today's robotic probes often operate their instruments on the same power as a light bulb and are highly constrained in when, how often, and how quickly they can visit planets and moons. The lifetimes of robotic rovers are limited to months by their power systems. If we are ever to send humans deep into our solar system, we will need more power and improved propulsion systems. Project Prometheus, a new NASA program started last year, is developing power and propulsion capabilities that will greatly enhance current robotic missions, enable new classes of robotic missions, and provide a key building block to enhance future human missions.

Eyes On the Future

In closing, I would like to paint a picture in words of where the space exploration strategy laid out in the NASA Vision and Strategic Plan will take us in the future.

Imagine a time in the not too distant future.

The world, from scientists to schoolchildren, is continually abuzz with excitement over discoveries and achievements made throughout the solar system by teams of human and robotic explorers. Robots roll, crawl, fly, and wriggle into every nook and cranny on the planet Mars, going where astronauts cannot, in the search for ancient and present life. Astronaut scientists at Martian outposts direct this robotic search and analyze specimens, reasoning in ways robots cannot, to understand the history of life on our sister planet.

Closer to home, astronaut engineers troubleshoot construction problems as robots assemble and maintain constellations of space-based observatories in Earth's neighborhood. These observatories provide breathtaking images of continents and oceans on Earth-like planets around other stars and unprecedented precision in understanding and predicting the global cycles of our home planet.

At the edges of our solar system, robotic divers plunge the watery depths of Jupiter's moons, mapping dark oceans and illuminating their potential inhabitants. Streaming video is sent back to Earth from these and other locations, allowing researchers and the public to experience the exploration of new worlds firsthand.

The space systems necessary to enable this vision, such as enhanced power and propulsion, intelligent robotics, high-bandwidth communications, lightweight materials, and modular and reusable components, have driven cutting-edge research in key sectors such as information technology and nanotechnology. Private industry and government employ these tools to benefit the economy, homeland security, and national security. The peaceful application of American technology is credited with opening the solar system frontier for humanity, and the United States has gone down in history as the nation that made the biggest scientific discovery of all time, life beyond Earth.

This is the future of space exploration if we faithfully implement the vision and strategy laid out in the NASA Strategic Plan. I sincerely appreciate the forum that the Committee provided today to highlight the NASA Vision and Strategic Plan, and I look forward to the opportunity to respond to your questions.