

Testimony before the Senate Commerce, Science and  
Transportation Committee  
Science and Space Subcommittee  
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Good morning Chairman Nelson, Committee Ranking Member Hutchison, Ranking Minority Member Boozman and members of the subcommittee. I appreciate this opportunity to participate in this very timely hearing concerning the ongoing significant and tangible contributions of the space program to our national imperatives, and the vital need to maintain our leadership on this endless frontier, especially since it occurs in the same month we commemorate the 50<sup>th</sup> anniversary of Alan Shepard's first American Spaceflight and President Kennedy's speech to Congress committing our nation to land on the moon.

I had the privilege and honor on two Space Shuttle missions and one expeditionary mission to the International Space Station, of logging 144 days in spaceflight. And while it is true that every day spent in space is memorable, there was one day while onboard the International Space Station that will remain seared in my memory as long as I live. To me this day serves as a constant reminder of why America's commitment to peacefully explore and utilize space for the benefit of our citizens and people around

the world is so vital for our collective future, and why we must not retreat on our leadership in space.

Ten years ago, I was serving as commander of the Third Expedition onboard the ISS, and was the only American physically in orbit. On the morning of September 11, 2001, I had just completed medical examinations of my fellow crew, Vladimir Dezhurov and Mikhail Tyurin, and called our flight surgeon with the results. Dr. Hart replied with the chilling words, “Frank, we’re having a very bad day here on the ground...” We were stunned as he described events on the ground in New York City, Washington, DC and Pennsylvania as they unfolded. I saw that our flight path was taking us over New England, so I was able to grab a video camera and focus, in horror, on the spreading smoke and dust enveloping Manhattan. We found out in a few hours that we had just witnessed the fall of the second tower. Later, after being assured by my wife that our scattered children were safe, I learned sadly that the Captain of American Airlines Flight 77, which crashed into the Pentagon, was my Naval Academy classmate, fellow fighter pilot and friend Chic Burlingame.

The next night, I wrote a personal letter to my Academy classmates gathered for our long-planned reunion. The letter concluded with, “It’s horrible to see smoke pouring from wounds in your own country from such a

fantastic vantage point. The dichotomy of being on a spacecraft dedicated to improving life on the earth and watching life being destroyed by such willful, terrible acts is jolting to the psyche, no matter who you are. And the knowledge that everything will be different than when we launched by the time we land is a little disconcerting. I have confidence in our country and in our leadership that we will do everything possible to better defend her and our families, and to bring justice for what has been done.”

My confidence that justice would be served began a month later as my classmates and friends entered harm’s way to punish those who harmed us – and was even better fulfilled three weeks ago. The dichotomy I wrote about after September 11<sup>th</sup> between a vile and doomed ideology, bitterly opposed to freedom and progress, and our peaceful venture to utilize the International Space Station for the noblest of human purposes serves as a useful point from which to discuss the critical need to have a strong and vibrant space program.

As I said, everything was different after we landed, but also different on board. We had a job to do, as did the brave and committed team on the ground, but our relationship with the ground changed. We spoke with and to an even larger number and variety of people than had been planned preflight – from royalty and prime ministers to special people such as Walter Cronkite

(twice) and school children displaced by the events at Ground Zero.

Always, it was if they were looking to us to prove that humanity can build together, can do great things, even in the midst of the unthinkable. It seemed they wanted to look to the sky for an example of something good, something positive they can point others to: an international project worth pointing your children toward – and they wanted to hear that the world still looked okay from up there.

Some in this room were around when we went to the moon from 1969 to 1972, in the midst of that other war – Vietnam – and while trying to heal wounds and solve issues with civil rights and civil liberties in our own country. It was an extremely difficult time, but we still had the ability and courage to expand our boundaries in space while changing society on earth and dealing with the realities of a conflict. And everyone remembers the significance of the moon landing, and how proud it made them to be alive at a time like that.

Today we should be equally proud that we now have a permanent presence in space, a place for our children to aspire to work, and to use as a steppingstone to their own new boundaries. The International Space Station, which NASA Administrator Charles Bolden rightly calls “the centerpiece of our human spaceflight endeavors for the coming decade, our

anchor for human exploration,” is not only one of the most amazing feats of human engineering, but also one of the greatest examples of productive international cooperation, whose use as a research facility will improve the lives of millions and help pave the way for humanities’ next great leaps to the moon, to the asteroids and onward to Mars. Space exploration, currently led by the United States of America is the true march of progress.

The ISS, a cooperative project between the U.S., Canada, the nations of the European Space Agency, Japan and Russia, is a tremendous example of “soft power”—the ability of the United States and our partners to expand our influence and capabilities because of the attraction of our values, goals, and technological leadership. I was well aware of that type of power projection as a career Naval officer and saw the benefits of it in port calls to almost forty countries around the globe. As the second manager of the Shuttle-Mir Program, the precursor to ISS, I also saw the incredible benefits of partnering with our former adversaries, learning their capabilities, and together, beginning to build the station that has provided humanity with a permanent presence in orbit for the past decade.

In addition, I believe the ISS is an ideal platform for conducting valuable scientific research and for developing and simulating the

operations, technologies, and techniques for executing more ambitious and lengthy missions to the Moon, Mars, and other destinations.

Outfitted with 15 pressurized modules the ISS has the volume of a five-bedroom house. To give you one example of its scope, the ISS solar array that powers the facility at 84 kw, has a surface area that could cover the U.S. Senate Chamber three times over. The ISS's capabilities include 34 research racks and 22 external locations for experiments. The Station is capable of accommodating 100-300 experimental payloads with crew science support of at least 2,000 to 3,000 hours per year.

When I returned to Earth from the Expedition-3 mission I came home on the Space Shuttle Endeavour. And this morning, the Endeavour—now on its final voyage—is once again at the International Space Station, adding to its capabilities with delivery of the Alpha Magnetic Spectrometer, a particle physics experiment that will measure cosmic rays and in an example of science at its most daring look for evidence of dark matter and antimatter in the far reaches of the universe. This scientific instrument owes its place on the space station directly to actions taken by the Senate.

Even though we are just reaching the point of near full assembly and the full potential of the ISS can begin to be utilized, research onboard the Station has already demonstrated its promise. Thus far there have been 214

published results from specific payloads and projects, and 20 publications on the ISS and future exploration technologies. I am very thankful this facility will operate at least up to the end of this decade and perhaps to 2028.

A few examples illustrate the stations promise. One of the most compelling ISS research results is confirmation that the ability of common germs to cause disease increases during spaceflight, but that changing the growth environment of the bacteria can control this virulence. An experiment identified the increased virulence of space-flown *Salmonella typhimurium*, a leading cause of food poisoning. Future ISS research will target a vaccine for this disease.

Another ISS experiment demonstrated a new and powerful method for delivering drugs to targets in the human body. Microgravity research on the station led to the development of miniature, liquid-filled balloons the size of blood cells that can deliver medicine directly to cancer cells.

The work to develop the Station's regenerative water recycling system to provide safe drinking water for crews onboard the Station has resulted in technology that can help in disaster recovery in areas where water purification is a significant issue after earthquakes and other natural disasters. The system has been used to provide purified water to Kurdish villages in Northern Iraq and for earthquake relief in Pakistan.

In a different area of research, ISS tests of how spacecraft materials withstand the harsh space environment have been used to develop longer duration solar cells and insulating materials for future commercial station cargo ships. This experiment has significantly reduced the time needed to develop new satellite systems, and paved the way for materials to be used in new NASA spacecraft that will send crews beyond Low Earth Orbit.

In one of my favorite examples, NASA built a facility at its Glenn Research Center to bombard materials planned for the ISS with atomic oxygen to test their durability. Atomic oxygen is an elemental form of oxygen that does not exist in Earth's atmosphere, but is common in Low Earth Orbit, and is known to corrode spacecraft. NASA engineers Bruce Banks and Sharon Miller realized their facility could be used to remove unwanted material from surfaces without ever needing to touch or rub them. Their invention was used to restore two 19<sup>th</sup> century religious paintings damaged by an arson fire at St. Alban's Church in Cleveland Heights, Ohio, and a vandalized Andy Warhol painting.

I'm confident that these promising research results are only the start of what we are going to see come out of ISS research. And thanks to the work of this committee and others in Congress, the 2005 NASA Authorization Act designated the U.S. segment of the ISS as a National



Laboratory. This designation will enable a non-profit organization to allocate valuable ISS experimental space for the most promising research proposals in the fields of biology, chemistry, medicine, physiology and physics as well as for astronomical and meteorological observation. The non-profit will invite research proposals from NASA, other governmental organizations, university researchers or the private sector.

I personally see the ISS as, at least, the virtual jumping off point for us to begin to send crews out to explore further in the solar system. And frankly, I wish we would be more aggressive in getting more crews up there to conduct more research.

The ISS is a vital research platform to understand the effects of the space environment on humans, with research aimed at protecting future explorers from the harmful effects of radiation in space, and to reduce the rate of bone and muscle loss that astronauts experience over lengthy periods of time in zero gravity. The ISS serves as a test-bed for developing spacecraft hardware and closed-loop life support systems, and to test operations for missions that will extend for millions of miles and years at a time. ISS crews will simulate our next great leaps in space, and help mature our understanding of human factors and the ability of explorers from diverse backgrounds to work in concert with each other in close-quarters for

extensive periods of time. The ISS will help us learn the skills of deep space logistics management, conducting remote medicine and managing communications when contact with Mission Control is minutes rather than seconds away.

With this knowledge we can be confident when the time does come to return humans to the Moon, to explore the asteroids, and eventually land on the surface of Mars.

Of course all this will be true only if we have federal policies that support a robust space program over a sustained period of time, if we maintain a highly-skilled and dedicated workforce, and if we continue to inspire the next generation of explorers to aim high for goals worth striving for.

NASA has been looking for innovative ways to develop new capabilities in space and has developed a government-private industry partnership for providing logistical support to the ISS. That partnership, the Commercial Orbital Transportation Services program, or COTS, will come to fruition in the very near future with new ground and space infrastructure to support ISS operations well into the future at a cost significantly less than the cost of a traditional government procurement.

With respect to how much we invest in the space program, I would imagine that members of the committee probably share my frustration that surveys show the public vastly overestimates NASA's budget, yet this is somewhat understandable given the high profile of our space missions. But I was simply astounded when I read a recent Congressional Quarterly cover story on the space program in which the author wrote that NASA's budget "has hovered at around one percent of the total budget since the mid-1970s." If only that were to be the case. Alas, the reality is that today's NASA budget represents less than one-half of one percent of the budget. If NASA's budget were actually a mere one percent of the federal budget this hearing would be almost unnecessary.

Today, I have focused my testimony on the value of the International Space Station. Of course a more richer understanding of NASA's contributions to our national imperatives must include a discussion of the agency's work to advance weather forecasting and understanding of our planet's dynamic climate, to warn of solar storms and spot potentially devastating Earth crossing asteroids, and to assist in natural disasters—with NASA satellite support for relief and recovery efforts following the Japanese earthquake and tsunami and Alabama tornadoes being recent examples.

It would also be worthwhile to discuss how NASA's science missions to Mars, like the upcoming Mars Science Laboratory, the ongoing Dawn mission to the asteroids Ceres and Vesta, and orbiting NASA observatories like the Kepler Space Telescope and soon to be launched James Webb Space Telescope will advance our understanding of the solar system and universe and the profound search for evidence of life in and outside the solar system, thus benefiting our nation's reputation as the pacesetter of scientific discovery.

And by all means, it's worth discussing how NASA contributes to economic growth through the thousands of jobs and hundreds of new industries created as a direct result of NASA innovation. To illustrate this point, when USA Today published a list of the "Top 25 Scientific Breakthroughs" that occurred in the newspaper's first 25 years, nine of them came from space and eight directly from NASA. Indeed, the term "spinoff" was invented to describe specific technologies developed by NASA for its missions that are transferred for commercial use or some other beneficial application. Thus far, NASA has documented more than 1,500 spinoff success stories related to health and medicine, transportation, public safety, consumer goods, environmental and agricultural resources, computer technology and industrial productivity.

There is one other aspect of spaceflight that was brought home to me in deep and sometimes very personal ways virtually every day I spent in orbit – and still now as I’m stuck on the ground. That is the effect of space exploration on the educational goals of our youth. Most of the people of this country – and of most other countries – especially the young people, see eventual access to space as part of their future, and maybe even as much a right as access to airlines and highways. It’s not clear that many people have a realistic understanding of the challenges of maintaining and growing our presence in orbit, much less through the solar system, but the ultimate product of that interest is the benefit to our educational system, the motivation for students to excel in STEM subjects, and hopefully to help maintain our leadership in the world on many fronts. I know from speaking to schools around the globe, both from space, and on my feet, that the space program’s influence on education is profound, but still not fully capitalized upon. As Administrator Bolden said, “Through the science, research, and technology demonstrations conducted on the National Lab [in space], we will build foundational knowledge, advance economic competitiveness, and prepare for the grand journeys ahead.

Finally, a discussion of NASA’s contributions to national imperatives must include the subject of which nation will be first among nations in

leading peaceful human and robotic exploration of the solar system while learning how to live and travel more safely and efficiently here on Earth. It is not a foregone conclusion that the United States will remain the preeminent spacefaring nation, and will reap the benefits of leading the march of progress beyond Low Earth Orbit. That is why I am gratified that this hearing is being held, and I am honored to sit alongside people who care deeply about our future in space.

In closing, I am proud that our nation continues to inspire people throughout the world for our commitment to freedom, creativity, exploration, and commerce, and through our leadership in the frontier that will define the future of human civilization. I feel a special responsibility because of my unique position as the only American who was off the planet on September 11, 2001, to spread the word that our leadership in space is vital to our way of life and our future, is a hard won accomplishment, and one we should never consider surrendering easily. In space we inspire respect, and sometimes envy, but always we show we are leading. Our freedoms allow us to do that. This, to me is the abiding lesson of being in space on September 11<sup>th</sup>.

Thank you for the opportunity to testify before this important hearing.