New Year's Resolutions

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Keynote Address
Academy of Medicine, Engineering and Science of Texas
5th Annual Conference

10 January 2008

Thank you for inviting me to speak before this Academy.

Before going any further, I would especially like to recognize and thank Senator Kay Bailey Hutchison, both for adding her voice to the invitation to speak here today, and for her leadership in the Senate in support of America's exploration of the space frontier, and the impetus it provides to American competitiveness in the world. We cannot carry out our missions without the support of our champions on Capitol Hill, in the White House, and among the American public at large. The Senator has been one of those who have truly supported us.

Since this audience represents a broad cross-section of interdisciplinary research, I would like to explore with you today some of the medical challenges we face in space exploration; how those

challenges compare with other means of travel on the land, sea, and air; and how the types of research NASA and many members of this audience are conducting today will further allow us to push back the frontiers of long duration human spaceflight. As we look toward to building future outposts in places not on this Earth, expanding the American frontier, we must also pay attention to how we can work with commercial and research interests to improve our way of life here on Earth.

Let me say from the outset that what we are endeavoring to do here – incorporating space into our economic sphere of influence – will be the most dangerous and difficult undertaking of the next century, and for many centuries beyond that. But this does *not* mean we should defer our efforts or lose sight of the strategic goals before us.

We have been in space now for almost fifty years. But, we have been in space for *only* fifty years. Many of you, me included, might wish that over the past fifty years our nation had taken "longer strides" in space, as President John F. Kennedy framed our nation's goals before the Congress in 1961. However, I am not one to look back with regret at

what might have been. I like to look forward to what will be – especially at the beginning of a new year.

In 2008, NASA celebrates its 50th anniversary, recognizing many milestones and events along the way, ensuring that we are headed in the right strategic direction for this long journey, and especially with the beginning of a new year, making determined resolutions to carry out the great task before us. Since January is the time of year when each of us sets certain resolutions or personal goals, mostly involving losing weight or improving a golf handicap, I thought that now would be a good time to make some resolutions for what it is we at NASA will endeavor to accomplish on behalf of our nation this coming year, in the context of where we started fifty years ago and where we headed today.

As you all know already, NASA was created in 1958 out of the shock of the Soviet Union launching *Sputnik* in October 1957. As Americans, we felt that we were facing a crisis, falling behind the Soviet Union, and it galvanized a unified, national response. In 1957 and the years that followed, the mastery of spaceflight was widely recognized as being strategically important to the future of our nation.

Two important pieces of legislation followed in 1958: the National Aeronautics and Space Act which created NASA and the National Defense Education Act which stimulated math, science, and engineering education in our country. I am sure many of you in this audience benefited from the many scholarships and research grants that resulted from this legislation. And, if you grew up in Houston, you were inspired to study math, science, and engineering by what was going on in your neighborhood, what our nation was accomplishing with the space program.

Though there have been numerous updates to the Space Act over the years in the form of periodic authorization bills for the agency, the guiding principles of the Space Act of 1958 have stood the test of time. There have been lots of changes, back and forth, but few real improvements. However, I firmly believe that the best of those in all that time has been the NASA Authorization Act of 2005, which Senator Hutchison sponsored and whose leadership brought it over the goal line to be enacted. A copy of this landmark legislation hangs on the wall just outside my office. It is important because, in the wake of the Space

Shuttle *Columbia* accident five years ago and President Bush's call for a unifying Vision for Space Exploration, the NASA Authorization Act of 2005 provides the properly balanced, strategic direction for our nation's space program for at least the next two decades. It represents our nation's resolve to honor our commitments to our international partners with the Space Station, to use the Space Station as a National Laboratory, and to build the *Orion* Crew Exploration Vehicle and Shuttle-derived *Ares* launch vehicles to "take longer strides", and carry out new missions beyond low-Earth orbit. It also properly balances these goals for human space flight with NASA's science missions and aeronautics research.

I would also like to thank Senator Hutchison for co-sponsoring the America Competes Act, which President Bush signed into law last August. This bill will better position American students and technical workforce to compete in the global marketplace. I hope that many of the next generation of students will carry the torch from one generation to the next on the frontier of space, just as I was inspired by NASA's achievements – and NASA's leaders – when I was growing up in the 1950s and '60s.

Our nation's leadership on the frontier of space as well as in the research laboratory will never be easy to maintain. Thus, we must periodically commit ourselves to this purpose. While the United States is a great country, we do not have unlimited resources. We must make wise decisions in how we apply our talent, energy, and money to the task at hand.

As President Kennedy framed this issue of American competition with the then-Soviet Union, "if we are to win the battle that is now going on around the world between freedom and tyranny, the dramatic achievements in space which occurred in recent weeks should have made clear to all of us, as did Sputnik in 1957, the impact of this adventure on the minds of men everywhere."

Fifty years later, as Senator Hutchison knows, I abhor the idea of paying Russia over $700 million, and possibly a good deal more, between now and 2012 to provide crew transport and contingency crew rescue for U.S. astronauts working on the International Space Station. I would much rather that NASA could pay U.S. commercial companies and their workers to provide these space transportation services.

However, it is strategically important for us to honor our commitments to our international partners, and if we could not avail ourselves of Russian crew transportation services, it would mean that the U.S. would not be represented on the Space Station which we built. If we were not there, the ISS would not survive. If there is no ISS, there is no market for the commercial providers we are trying to help bring into existence, and the international partnership we have so painfully built over the last two decades will fall apart.

So, while I do not like the idea that the United States has no option other than to purchase crew transport services from Russia, I am glad that there are Russian services to buy, because the consequences of not doing so are the worst outcome of all. As my colleague, Russian Space Agency Head Anatoly Perminov has said, the world needs more than one human space transportation system. He is right, and we are fortunate that Russia is part of the ISS partnership. Their participation gives us time to develop the next generation of crew transport systems, while preserving the investment we have made in the ISS. But I will yield to none in my belief that we need to minimize this period of dependency, and that we need to

get back into the game as soon as possible. If we cannot do that, we will have failed to lead. I find that an intolerable position for this nation.

This is not a problem which arose overnight. I have asked the question on many occasions: why does it take a crisis to capture our attention? This situation – U.S. reliance on Russia for Soyuz crew transport, as well as plutonium to power NASA's outer planets missions – grew up over the course of many, many years, with a series of decisions, or often simply benign neglect, concerning the strategic implications of our actions, or lack of action. To be blunt, in my opinion the *Columbia* Accident Investigation Board got it exactly right when they said, "previous attempts to develop a replacement vehicle for the aging Shuttle represent a failure of national leadership" and "this approach can only be successful… if the U.S. government is willing at the time a development decision is made to commit the substantial resources required to implement it."

For this reason, my resolution for 2008 is to fight for the COTS program, to spur the development of U.S. commercial space transportation services to and from the International Space Station. I

make this resolution because I firmly believe it will enhance U.S. access to Earth orbit and the International Space Station, while providing substantial savings to the taxpayer compared to NASA government-owned and operated capabilities. While I will of course respect the Congressional direction in this year's appropriation for NASA on COTS, I will be asking the Congress for the funds in 2009 to maintain NASA's promised $500 million investment in the program. I hope to award contracts to U.S. companies in the coming weeks ahead, once we clear all legal challenges.

My second resolution for 2008 is to ensure that NASA's replacement system for the Shuttle, the *Orion* Crew Exploration Vehicle and *Ares I* crew launch vehicle, is well underway in its design, development, and flight demonstrations. While I wish that NASA could bring this new capability online sooner, it would be far worse if I were to over-promise or fail to provide my most credible, realistic assessment to our stakeholders in the Congress. With the budgetary resources currently projected during the critical development years of 2009 and 2010, we can reasonably forecast the *Orion* and *Ares* systems coming online by early

2015. That being said, the engineering and design teams for the *Orion* and *Ares* here in Houston, Huntsville, Cape Canaveral, Cleveland, Denver, and many, many other parts of the country are trying to beat this prediction. Godspeed to them.

My considered assessment of the Constellation Architecture is that we are not facing any technical showstoppers, but we must – of course – make a number of engineering design choices as we reach the preliminary design phase this year. Constellation is primarily a systems engineering and integration effort, with a great deal of flight-proven hardware – the capsule design of *Orion*, the Shuttle-derived *Ares*, and the *Apollo*-era J-2X upper stage engine – and I am extremely proud of the progress this multi-disciplinary engineering team around the country has made thus far.

Now, my highest priority resolution for the coming year ahead is to carry out safely several Space Shuttle missions on the path to assembling the International Space Station. After a lengthy delay last year, when a sudden hailstorm over Cape Canaveral damaged the Shuttle's external tank, we carried out three successful Station assembly missions. We were set to conduct a fourth mission, STS-122, with the European *Columbus*

Module, just last month. Unfortunately, we encountered persistent problems with the liquid hydrogen engine cutoff sensors due to intermittent open circuits which we believe lie in the feedthrough connector on the liquid hydrogen tank. The Space Shuttle team now has a plan to replace the connector and resume the launch flow. We still have additional work before we can set an official launch date.

In addition to several Space Station assembly missions, including the Japanese Kibo laboratory, I am *really* looking forward to the final Shuttle servicing mission to the Hubble Space Telescope later this year. With the planned launches of the GLAST, Kepler, and IBEX astronomy and astrophysics missions, along with several Earth science and heliophysics missions, 2008 looks to be one of our busiest years.

Not many people realize that 2007 was the busiest year ever for extravehicular activity – spacewalking – at NASA. Our astronauts carried out almost 144 hours of EVA, almost 10% of the 1,500 hours of total EVA time conducted in the entire history of the U.S. and Russian space programs. Again, we have been exploring space now for 50 years, but it has only been 50 years. With the Space Station, NASA and our

international partners have maintained a permanent human foothold in space since October 2000 – over seven years, and we are still learning the hard lessons of how to live and work in space 24/7/365.

Perhaps the most dramatic spacewalk of the year was taken by Scott Parazynski, in November. When a Space Station solar array ripped in two places while unfolding – with one rip nearly three feet wide – the Shuttle and Station astronauts and the engineers and operators in Houston and Moscow had a difficult challenge on their hands, and they knew the potential consequences. If the torn solar array could not be fixed, if the array was not stable enough to track the sun or allow vehicles to dock with ISS, it might be impossible to generate the power required to run the ISS. Many engineers literally worked around the clock for almost a week to attempt to fix this problem. In a scene reminiscent of the *Apollo 13* crew jerry-rigging spare equipment for an air scrubber, astronauts onboard the Station last fall devised some aluminum strips to form a homemade brace, or "cufflinks", as they called it, for the torn solar array. They then borrowed a robotic boom arm from the Shuttle and attached it to the Station's fifty-seven-foot robotic arm to extend the reach of the

astronaut out to ninety feet, because the torn solar array panels were so far away. Working from the end of the ninety-foot robotic arm, 6'2" Scott Parazynski used his full height and his Stanford Medical School training to make a careful incision into a "hairball" of tangled guidewires, and suture together the torn solar arrays with those "cufflinks". Scott and the many other astronauts, ground controllers, and engineers who supported him saved the International Space Station that day, and we owe them a debt of gratitude. Of course, they think it was just another day on the job.

These are the difficult lessons we will need to learn to carry out the Vision for Space Exploration set forth in the NASA Authorization Act of 2005. Space exploration is not for the faint of heart, or the easily distracted. Long-term dedication and – dare I say it – bravery are required to meet the challenges that occur when mankind attempts any journey out beyond where the streetlights shine.

Humans have walked the Earth for 200,000 years. Over the millennia, we tamed beasts and built ships to sail across rivers and oceans. Only 200 years ago, the first steam trains were used in Great Britain, and it was only a little over 100 years ago when the first internal combustion

engine powered an automobile. The first powered flight took place at Kitty Hawk in 1903. So, in only the first fifty years of spaceflight, it is actually quite remarkable to realize that NASA's robotic spacecraft have ventured to almost all planets in the solar system, four have actually left the solar system, and that twelve men have walked on the Moon. We are in the midst of constructing the International Space Station, which will be larger in wingspan than a football field and weigh about what the first Mars ship will weigh. Its development is the largest task ever performed by the civilian agencies of the United States or our international partners; only military coalitions have undertaken larger efforts.

We humans have faced many dangers in the journeys of our history. When we ride horses, we take precautions from falling or being injured. In the early years of transoceanic voyages, many sailors suffered from scurvy, and many more died from other causes. It was not until the late 1700's that Captain James Cook commanded a voyage where no one died of scurvy. Still, thirty-eight of 102 sailors died on the first voyage of *Endeavour* – yet Cook was praised for his exemplary care of his crew upon his return. And we still haven't conquered the ocean. Even today,

many people suffer from seasickness, which of course doesn't kill you – it just makes you think that it would not be a totally bad thing if it happened.

Medical challenges abound in aviation, and we have developed many countermeasures over the years to fight exposure to hypobaria (causing the bends), hypoxia (lack of oxygen), and hypercapnia (too much carbon dioxide), to name only a few of the difficulties.

In space, we will need to develop the necessary countermeasures to shield against various types of radiation, the effects of extended weightlessness on the human body, and to ensure that we have the human factors right so that our astronauts can endure extended periods of separation from the Earth in confined ships journeying not only to our Moon, but eventually to planets and moons beyond cislunar space. Thus, we will rely on the International Space Station as a scientific and engineering test bed, a National Laboratory according to the NASA Authorization Act of 2005, to test these many countermeasures.

One of our success stories is our work to develop countermeasures against kidney stones. In microgravity, the human body compensates for

the lesser stress on the skeletal system by releasing calcium from our bones, making astronauts prone to increased risk of developing kidney stones. In order to prevent their formation, astronauts have been taking potassium citrate. Also, we have been conducting experiments with a new generation of pharmaceuticals with companies like Amgen to test methods of preventing or reducing this osteoporosis-like bone loss, as well as preventing the muscle atrophy which also arises in zero-g.

Based on an experiment with salmonella, a common food-borne bacteria which causes disease in humans and animals, conducted onboard the Space Shuttle *Atlantis* in 2006, an Arizona State University research team published a paper last fall concerning an increase in virulence found to occur in salmonella when exposed to the space environment. This research may lead to new techniques for treating salmonella poisoning. While NASA has never had a serious crew health issue, and the handling, preparation, and storage of food for our astronauts is of the highest standards, we need to be vigilant in protecting against this disease.

Last year, a convention of the American Medical Association endorsed NASA's efforts in human spaceflight, in going to the Moon and

beyond, because the technologies and techniques we have developed for doctors will "undoubtedly yield both projected and unanticipated biomedical breakthroughs." The AMA resolution listed several NASA contributions to their work, including LASIK surgery, laser angioplasty, dialysis machine improvements, and digital cochlear implants.

Last September, Elias Zerhouni of the National Institutes of Health and I signed a Memorandum of Understanding to conduct even more joint medical research onboard the Space Station. On the next Shuttle flight, NASA astronauts and NIH researchers will test a drug called midodrine intended to reduce the dizziness which often results from a drop in blood pressure when our astronauts first return to Earth from the zero-g environment of space.

In these many small but significant ways, I firmly believe that we are honoring the legacy of the crew of the Space Shuttle *Columbia*, five years after they gave their last full measure of devotion to our nation's space program. You will recall their mission on STS-107 was to conduct a host of biomedical research experiments. Their journey continues, just

like it did with the sea voyages which followed in Ferdinand Magellan's wake five hundred years ago.

NASA's biomedical research for space exploration follows also in the footsteps of Dr. Michael DeBakey, who will be celebrating his 100th birthday this year. As many of you probably know, Dr. DeBakey and NASA have conducted a great deal of research together, going back to the time he performed a heart transplant on a Johnson Space Center engineer back in 1984. A collaborative effort grew out of that relationship between Dr. DeBakey, JSC, and other NASA research centers, where we applied our expertise in complex computational fluid dynamics and supercomputers to the task of improving artificial heart designs and blood flow.

Senator Hutchison, on behalf of NASA, I want to thank you for sponsoring the legislation last year to honor Dr. DeBakey with the Congressional Medal of Freedom. He has made a lasting contribution to improving life on Earth through the application of technologies and capabilities developed in our nation's space program, and we are inspired by his example.

In closing, I would like to recognize a nearly forty-year old milestone of spaceflight that still speaks volumes to us today, as we make resolutions for what we hope to accomplish this year. Former NBC News anchor Tom Brokaw recently wrote a book and hosted a History Channel documentary about the tumultuous times of 1968. I was a college sophomore that year. With the Vietnam War, the assassinations of Martin Luther King and Robert Kennedy, the struggle for civil rights and women's rights, protests on college campuses, and the Presidential campaigns and election that year, 1968 was a time of great upheaval for our nation.

Tom Brokaw points out a number of parallels between 1968 and today. He ends his analysis of that year with a reminder of what the Apollo 8 mission in December 1968 meant to our nation and the world. On Christmas Eve, the crew of Apollo 8 – Frank Borman, Jim Lovell, and Bill Anders – read from the book of Genesis as they cruised in orbit around our Moon. They saw our fragile Earth rise over the barren horizon of the Moon, and Jim Lovell looked back at the Earth, held up his thumb, and blocked it out. He has since said that he realized in that moment how

small the world he once knew was when compared to the vast frontier of space. With all the turmoil of 1968, this mission and this transcendent moment helped all of us to realize that we must overcome our common struggles if we are to achieve better things for ourselves and future generations.

We need more moments like that. And then we must resolve not to forget them, to carry the torch, to pass it on to the next generation, because with your help, I believe that one day, a future astronaut, someone in many ways not unlike Jim Lovell, will look back at the Earth in the rear view mirror and keep going. And I hope that this future astronaut reminds herself: Objects in the mirror are closer than they appear.

Thank you.