Issues Du Jour

Remarks

by

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to the

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Good morning. Thank you for inviting me to speak here again this year. The American Astronautical Society's annual Goddard Symposium is one of those events I look forward to each year, an opportunity for all of us to catch up with old friends. And guess what? It also means another opportunity to wear a tux, at the annual Space Prom this Friday night. Aren't we all thrilled?

The theme for the conference this year is appropriate – looking back fifty years to *Sputnik*, and forward to *Orion* and *Ares*, the first elements of the Constellation program. Many historians have analyzed the cultural significance of, and uniquely American reaction to, that "Sputnik moment" in 1957, when our nation's leadership first grappled with the question of whether the United States should become a leader in space exploration and, if so, how should we go about it?

That question was settled on May 25th, 1961, when President Kennedy made one of the most significant speeches in human history, saying, "But this is not

merely a race. Space is open to us now; and our eagerness to share its meaning is not governed by the efforts of others. We go into space because whatever mankind must undertake, free men must fully share… I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth. No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish."

Americans are by nature a competitive people, and I believe that our country is an enormously better place for having accepted the challenge that President John F. Kennedy put before us in 1961. Because of it, America has been the leader on the space frontier for the past two generations. Our nation has a long, proud history of pioneering spirit, from the founding of Jamestown, to the Lewis & Clark expedition up the Missouri River across the plains and Rocky Mountains to the Pacific Ocean, to the Apollo moon landings, to the tour of the solar system by Voyagers 1 and 2, to the Mars Exploration Rovers *Spirit* and *Opportunity*.

However, since I am simply the warm-up act for Roger Launius this morning, I won't presume to review the history of *Sputnik* or what followed. Compared to Roger, John Logsdon, Howard McCurdy, or Henry Lambright, I think the most that might be said of my capabilities as a historian is that I should not give away my engineering texts.

But I do believe the most significant and lasting outcome of our national reaction to *Sputnik* was the creation of NASA in 1958 as the agency responsible for our nation's civil space program. I am extremely fortunate to be NASA's 11th Administrator, and to be leading NASA at this particular time in the organization's history. I realize this every day.

Now, the only thing more dangerous for me to do than discussing the history of our space program, is to prognosticate its future. Yet I did just that recently, in the online edition of one of our field's more sober trade journals, *Aviation Week & Space Technology*. I was asked by someone having more chutzpah than taste to write an essay on my personal predictions for the next fifty years of human space exploration. My thoughts are captured in the poetic, flowing, captivating style you would expect of an engineer and MBA. I commend it to your attention, but be sure to have some strong coffee by your side as you read it.

My goal with this dispassionate and rather analytical thesis was to go beyond the personality-dependent sound bites we see so often in the public arena, to get past the myths of our past, and to analyze the possible future of our civil space program with a macro-view of what is possible if we focus our time, energy, and resources on proper goals, strategic goals. In doing so, I made what I believe to be a fairly conservative assumption by extrapolating NASA's budget as fixed in constant dollars at today's level. If you haven't read that article, maybe I can

entice you to do so by saying that one of the conclusions that emerges is this: if we continue to receive today's budget in inflation-adjusted dollars – no more and no less – we will have enough money to do an Apollo-scale program, *three times over*, and more, by the 100th anniversary of *Sputnik*.

That being said, anyone's ability, including mine, to predict the course of the next fifty years with any level of precision is more than somewhat suspect. The one thing of which we can be certain is that in trying to envision the world of 2057, two generations in the future, we will be wrong. Who would have predicted in 1957 that, today, Americans and Russians, as well as Japanese, Europeans, and Canadians, would be living and working together on the International Space Station? I certainly hope my thesis for the next fifty years in space exploration will hit closer to the target than the speculations of 1957, but I know that in numerous ways I will be proven quite wrong. I just don't know how.

But today, rather than talking at length about the past or the long-term future, let me focus on some of the current, pressing issues of the day that are particularly relevant to the work going on at Goddard Space Flight Center. As I am sure Ed Weiler will attest, there are some days, many days actually, that in dealing with the gamut of issues large and small facing NASA, we are reminded of the beginning of Charles Dickens' *A Tale of Two Cities*, "It was the best of times, it was the worst of times". When we at NASA dare to do great things and have

some small measure of success in so doing, those are certainly the best of times. The feeling of accomplishment from a job well done for a worthy goal, something bigger than oneself, something for the betterment of mankind, something to enhance our understanding of our universe, is the best of times. These are the real reasons why people like those of you here got into the space business.

But, naturally, when we dare to do great things, we will also inevitably experience great difficulty along the way. In part, this simply makes those things worth doing. What we do really *is* rocket science. But beyond overcoming the physics and engineering challenges inherent to our business, any number of other things can cause us to flag or to fail – contractual, legal, and bureaucratic impediments, and certainly Mother Nature.

A few weeks ago, a severe hailstorm caused over a thousand divots in the Space Shuttle's external tank, also impacting *Atlantis*' left wing. Thousands of men and women who worked thousands of hours to prepare the Shuttle for that mission had to turn around the whole process after a hailstorm lasting only a few minutes. The next Shuttle mission is delayed for at least a month as we assess the damage and remedy the situation. We will know in the next several weeks whether we can repair this tank and fly in May, or that it would be better to switch tanks and fly in June. We will let the work and the analysis pick the launch date, rather than pick a launch date and force the work to support that date. The teams'

response to this challenge is amazing. The folks from JSC, MSFC, KSC, and the contractor communities of USA, Boeing, and Lockheed are all pulling together to solve this problem. The progress made so far is incredible, but there is a lot still to go.

Even more dramatically, when Hurricane Katrina struck the states of Louisiana and Mississippi and NASA's Michoud Assembly Facility and Stennis Space Center, we almost lost the Space Shuttle program. Viewing the area by helicopter a few days after the hurricane, Michoud stood out as an island of green in a sea of brown mud, 150 miles long and three or four miles wide. But for the bravery of about forty volunteers on the ride-out team who risked their lives to protect Michoud from 178 mph wind gusts and, literally, a billion gallons of water, that island of green wouldn't have been there, and we would no longer have the ability to build the Shuttle external tanks.

Thus, when we make the next discovery about the origin and structure of our universe from the Hubble Space Telescope, with images from Wide Field Camera-3 or subtle data from the Cosmic Origins Spectrograph, instruments that we will carry on the next Hubble servicing mission, we need to thank those volunteers from the ride-out crew for risking their lives to make it possible. They literally saved our nation's space program.

My hope is that those people can look at those amazing pictures from the Hubble, or look up in the night sky to see the International Space Station overhead, and say to themselves and their children that they were part of making something great and meaningful happen during the course of their lives. Sure, there was hardship along the way, but perseverance in the face of such hardship is what makes us a great people and a great country. Sometimes the 'worst of times', brings out the 'best' in us, strengthening us for the future, and ultimately allowing us to experience the 'best of times'.

There are countless problems to be faced in trying to carry out NASA's programs, but there are also moments of immense pride. Continuing Dickens' train of thought in explaining the contrast between the best and worst of times: "it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to Heaven, we were all going direct the other way." Keeping those thoughts in mind, I would now like to discuss some self-inflicted problems that I believe are particularly relevant to NASA missions being carried out nearby at the Goddard Spaceflight Center.

First, I think one of the systemic problems the space community faces is the inability to set realistic expectations. We speak in lofty terms about the goals we

seek with our space missions, and we should, but let me speak now about some brass tacks. Every time NASA or the scientists and researchers we support have low-balled a cost estimate or over-promised on the technical feasibility of a project or program, we have lost credibility with our overseers in the White House and Congress, and, more importantly in the long run, the American people. As a matter of public policy, we as a nation do not seem to be willing to provide sufficient money for NASA to do everything that everyone would like us to do. Thus, we must make carefully considered choices.

Therefore, the primary theme that I and our Associate Administrators have established for program planning at NASA is that we must bring forward realistic programs, executable within the budget portfolios. NASA's program managers must find the proper balance between being aggressively success-oriented and overly risk averse in managing their programs. We need hard-nosed realists who can corral these competing, sometimes contradictory desires. To be sure, it is a difficult balance. I love the quote attributed NASA's greatest Administrator, James Webb: "The process of management became that of fusing at many levels a large number of forces, some countervailing, into a cohesive but essentially unstable whole and keeping it in a desired direction." This is so exactly right. I especially call your attention to the fact that Webb understood that the necessary balance is inherently unstable. Program management for large, complex systems

such as the ones we develop requires just such an understanding, and the excellence to deal with its consequences on a day-to-day basis, making real choices in the real world, and then waiting two years, or five, or ten, to find out whether you did it right. It's not for everyone, that's for sure. In the space business, we live up to a creed of excellence, or die from the lack thereof.

Now, in setting priorities within a particular scientific discipline, one of the great strengths of the space science community has been the establishment and use of the National Academy of Sciences decadal surveys. These surveys are essential for shaping our funding choices for flight projects within our disciplines of Earth science, heliophysics, planetary science, and astrophysics.

The astrophysics decadal was particularly helpful to me last year when working through the priorities for the Hubble Space Telescope, Webb Space Telescope, Space Interferometry Mission, and SOFIA mission. Yesterday, I had the pleasure of meeting the new chairman of the German Aerospace Center, Dr Johann-Dietrich Wörner, and we spoke about the way forward for SOFIA. After careful consideration last year, I believe that we're up to the challenge of the remaining work to be done in flight testing the B-747 and operating the 18 metric ton infrared telescope built by the DLR.

I was especially glad to have received the first-ever decadal survey, requested by NASA, NOAA, and the USGS in 2003, for the Earth Science and

Applications program last January. The relative priority ranking of the missions that the Earth Science community believes important has already been useful to me, and it will continue to be. However, when the decadal surveys, including the Earth science report, publish rough cost estimates for several missions that are obviously off the mark by a factor of two or more, we have a self-inflicted problem within the space community that affects the credibility of all. It poses a huge, distracting, and unnecessary challenge for NASA in managing not only the expectations of the science community in regard to a particular mission, but also of our stakeholders in the White House and Congress. Our overseers are given to understand from these published reports what the appropriate National Research Council panel believes such missions will cost, and what can be afforded within the decade. Then, later, I am on the receiving end of pointed questions that go something like this: "The National Academy said mission X would cost only a certain amount, but NASA mismanagement has obviously overrun the costs because you're now saying it cost three times that amount. How did NASA screw up mission X?"

I have no problem taking blame when properly due. However, the real problem began with the original report underestimating the cost. So, how do these low-ball cost estimates get into the NRC reports? Understandably, when putting together a decadal survey, the National Research Council panel and staff must

partition their work from the NASA headquarters managers who run these programs. So they seek information among the principal investigators and project managers who are advocating for the merits of their proposal. I'm sure that you will be shocked – shocked – to hear that the people involved are not completely disinterested with regard to the status of their particular mission proposal. They provide optimistic cost estimates, enhancing the odds that their project will be seen favorably by the NRC reviewers. The situation is further complicated by the fact that, generally, neither the NRC panel members nor the various PI's have, or should be expected to have, any particular expertise in cost estimation. They truly have plausible deniability!

Now, I can fully understand the motivations of the people involved. However, we need to ask the science community to police those individual motivations when it comes to over-promising on the costs for proposed missions. Too many people are simply trying to fit ten pounds of program into a five pound bag of budget. Simply put, we need a reality check on cost estimates for proposed missions.

One of the things I did in my first days as Administrator in an attempt to re-establish some credibility in this area was to establish an Office of Program Analysis & Evaluation, not unlike that at the Pentagon, where we brought together NASA's cost estimating experts, those responsible for program budget

formulation, and those responsible for the independent program assessment function.

Thus, my recommendation to future National Research Council decadal study team members and staff is this: for the next decadal surveys, use preliminary cost estimates from NASA's PA&E office, in order to provide a better initial cost estimate for flight projects, while preserving the partition between the decadal survey team and the mission directorate.

Now, allow me to also address some other points that have been raised from the recent Earth Science decadal survey. First, this decadal goes beyond setting a research strategy for its discipline and adjudicating mission priorities within it, and brings forth a rather brazen recommendation that more money be allocated to Earth science. I'm sure you're surprised. This is a clear attempt to upset the traditional funding boundaries between and among the various scientific portfolios at NASA. And some members of the science community have gone so far as to say that we need to delay human spaceflight and development of the *Orion* CEV in order to pay for more Earth Science missions and research. This is a false choice.

President Thomas Jefferson faced an analogous debate when he first requested "the appropriation of two thousand five hundred dollars, for the purpose of extending the external commerce of the United States" with what became the Lewis and Clark expedition across the newly-purchased Louisiana Territory and

the rest of the American continent. Members of the Federalist Party thought that monies should instead be spent for building the infrastructure of the Northeastern states rather than expeditions in far off lands. That was a false choice, and Jefferson wasn't fooled.

President John F. Kennedy faced partisan resistance when he first proposed a mission to the Moon. Kennedy was the first president to realize that human spaceflight is a strategic capability for our nation. On the day he was assassinated, he said: "For more than three years I have spoken about the New Frontier. This is not a partisan term, and it is not the exclusive property of Republicans or Democrats. It refers, instead, to this Nation's place in history, to the fact that we do stand on the edge of a great new era, filled with both crisis and opportunity, an era to be characterized by achievement and by challenge. It is an era which calls for action and for the best efforts of all those who would test the unknown."

We are now facing an approximate 4.5 year gap following Space Shuttle retirement when the United States will not have its own human spaceflight capability. I often wonder what the science community would say if they, and not the human spaceflight community, were facing such a desert of opportunity? If *Orion* is further delayed, we will be ceding our nation's leadership in human spaceflight at a time when Russia and China have such capabilities, and India is developing them.

Leadership is an elusive quality, for a person or a nation. It can only be conferred by agreement of others; it cannot be self-assigned. It can be earned, but it cannot be bought. And it can just slip away, almost without notice.

When what we think of as the Space Age began in 1957, America was clearly not a leader, despite our possession of clear leadership in aeronautics in the post-war era. In some of the great speeches of his time, or any time, speeches rife with prose that really was almost poetic, President Kennedy repeatedly acknowledged that fact, while vowing that America would one day be first in space. He didn't live to see it, but it happened. By roughly the end of the Gemini program, in late 1966 or early 1967, the U.S. really had claimed the lead in its Cold War space competition with the then-Soviet Union. I was 17 or 18 years old at the time, and I recall that we didn't really see it then, but looking back, it is clear that the torch had passed. The United States would remain preeminent in space for the next four decades. And, for a time, if NASA had something to say about space, people listened, and heard it as truth.

It's not that way anymore. We are one among several societies, soon to be more, cooperating and competing on the space frontier. Both of these strategies are natural, and are to be valued. But, I think, Americans still want our nation to be first among equals, to be in the lead, whatever that means and however it is determined. And at present we are, though not in the across-the-board sense one

would have observed in, say, 1975 or 1990 or 2000. But it can slip away far more easily than it was brought within our grasp. We must pay attention. We will not retain leadership by further delaying *Orion* and *Ares*, by not flying in space when others can.

During the Apollo development decade, 1959-68, NASA's Earth and space science budget was 17% of the overall NASA budget. Aeronautics, space technology, and communications research collectively consumed 15% of the budget. By the early 1990s, the figure for science had grown to 24% of our portfolio, and today, Earth and space science account for almost 32% of our FY08 budget request of $5.5 billion. When does enough become enough?

It is often said, today, that the growth in human spaceflight programs is endangering science at NASA. I hear it constantly. Some of you may have said it! But, what growth? Human spaceflight in NASA's first decade was 63% of the portfolio, and is 62% of the budget today. Within experimental error, that is the same number. The plain budgetary fact is that those who would pursue research in aeronautics and space technology have made sacrifices to allow growth in science. The science budget has not been sacrificed for anyone, or anything.

The enduring schism between our science and human spaceflight communities – a part of the landscape in space policy since my childhood – has been incredibly harmful over the decades, and simply need not exist. The

historical record is clear to those who will view it with a willingness to understand what it is telling us. Without the bold challenge of extending human presence into the Solar System, NASA likely would not exist, and space science would probably be a small portion of the National Science Foundation's portfolio. Without the breathtaking intellectual achievements of, and future possibilities for, Earth and space science in conjunction with human space exploration, that discipline would lose one of its motivational underpinnings. And, oh by the way, without an equally robust aeronautics program, both human spaceflight and science would be handicapped. Exploration Systems is relying on the Aeronautics Research Mission Directorate for assistance with entry systems design and analysis. Our Mars entry probes today still operate within the boundaries of the state of the art in aeronautics that was established during the Viking program of more than three decades ago. We can do better.

I hope that you will agree with me that NASA's three mission areas of space exploration, scientific discovery, and aeronautics research are all strategic capabilities for our Nation. And further, that they can operate in balance and synergistically with each other.

Speaking of balance, one of the first problems I sought to fix when I arrived at NASA two years ago was to re-establish the budget balance that had been disrupted between the Earth science and the Mars science disciplines. Today,

NASA's Earth Science budget request before the Congress is for $1.5 billion of the $5.5 billion requested for our total portfolio of Earth science, heliophysics, planetary science, and astrophysics. This is approximately 27% of NASA's overall science investment. NASA is the largest contributor to the inter-agency Climate Change Science Program (CCSP), and has been so throughout its history. NASA satellites supply more global climate change data than those of any other organization in the world. NASA provides the most grant-based research funding, with over $450M this fiscal year, or 40% of the CCSP scientific research total.

While the Earth science decadal survey focused on the number of Earth science missions between 2000-2010, and I do not dispute the facts as they were presented in their report, it might be more useful to look at the number of Earth science missions and instruments over longer time scales, like the number of instruments since 1990. We should also look at the assumptions behind the numbers cited in the report. The drop in the number of missions in 2005-06 is due to the retirement of the ancient (by space standards) UARS, TOPEX, and ERBE satellites after they had operated for almost fifteen years. The drop in 2008 is due to the assumed retirement of aging USAF DMSP satellites. NASA currently operates fourteen Earth-observing satellites which provide research data on the Earth's oceans, atmosphere, and land. Some of these satellites are approaching a

decade or more on orbit, and they continue to provide science data beyond the satellite's original baseline mission.

Before we even start looking at the new Earth Science concept missions in the decadal, I would note that just in the last eighteen months we have gotten GLORY, LDCM, and GPM either started or solidly in the budget. Three new missions in that span of time is a pretty good start on the goals of the decadal.

Given these facts, I am concerned that some Earth scientists are using this recently published decadal survey to advocate for funds from other portions of NASA's budget. Whatever the source, if done, this will unbalance the science portfolio. NASA's overall science portfolio is guided by all four decadal surveys from each of the disciplines, not just one. Given all of this, I believe that the Earth science community should regard this as the best of times for their profession, not the worst.

That said, while I am not a scientist, I try to keep up with progress in the sciences, and I truly believe that NASA's climate change research has garnered world-class results. There are indeed great societal implications for the research coming from NASA-sponsored missions and scientists showing, based on the Earth's average temperature, that 2005 was one of the five warmest years in the past century, and that 2006 was one of the ten warmest. It is now understood that the Earth is, on average, about one degree Centigrade warmer than it was a century

ago. NASA satellites have also observed a reduction in the ocean's food supply of microbial phytoplankton due to global warming trends. NASA satellites have observed the loss of sea ice in the Earth's polar regions, and because Antarctica holds 90% of the Earth's ice, this leads to a rise in sea level. As Senator Mikulski pointed out to me last week, "I don't want to be in a kayak at Goddard due to global warming."

In closing, before taking your questions, I would like to leave you with one last thought.

We have the most comprehensive view of the universe, the Solar System, the Earth, and our atmosphere that we have ever had. It has been achieved with great effort and at great cost, but it has truly benefited our society. We are enlarging that view as I speak with you today. Our sacrifices have reaped rewards. These are, truly, the best of times.

Thank you.