

Science and NASA

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Good morning. I want to thank everyone for taking time from your schedule for this all-hands session. I apologize for the fact that this meeting was called on relatively short notice, but with both weather and vehicle problems contributing to considerable uncertainty around the launch of Space Shuttle *Atlantis*, I had asked Ed Weiler to hold off on announcing this all-hands until we knew where we stood with the STS-115 mission.

Having been involved with many launch campaigns over the years, I've learned to respect the uncertainty of weather conditions at the Cape in the summertime. As Ed will tell you, I've wanted to come to Goddard for some time, to visit again and to discuss the role of science within NASA. Indeed, to my point about weather at our launch ranges, our nation's ability to predict the weather as well as we do is due in large part to the work of the many scientists and engineers right here at Goddard and their colleagues throughout the nation and the world.

Before opening it up to Q&A, I'd like to share with you my thoughts on some issues that seem to have disturbed quite a few members of the scientific community. Many of my friends have spoken to me about these issues. And there's been a lot of hyperbole flung about in the media during the past several weeks about NASA's "decimated science program", how NASA has rejected its responsibilities in the study of Earth science, and how we're not listening to our advisory committee.

So, let me be clear at the outset with my response to such hyperbole: Nothing could be farther from the truth. And frankly, as someone who's spent a good part of my engineering career building NASA science satellites, I think that this sort of unfounded rhetoric hurts the overall space program, including space science. But allow me an opportunity to offer a few points as I see them to ground the discussion in fact before opening it up to your questions. My intent is to change this debate into a more thoughtful, objective dialogue about the issues facing

NASA's science and exploration programs than what has been presented in many circles. I'd really like to reduce some of the angst in the community.

As I see it, by any objective measure science is doing well at NASA. Within the context of a national policy mandating a return of humans to deep space and adherence to our international commitment to use the Space Shuttle to complete the assembly of the International Space Station, NASA is maintaining many vigorous science programs, not the least of which will be the opportunity to reconstitute a productive program of human and robotic exploration of the Moon.

The Science Mission Directorate (SMD) FY07 budget request is \$5.33 B, up from FY06 by 1.5%. And we have an Administration (not just NASA), that is committed to preservation of SMD funding in FY08-10, albeit at a lower growth rate, 1%, than we all would like. In FY11 and beyond, SMD funding tracks Agency top line growth.

I must note here that FY08-10 are very, very difficult budget years at NASA, because we are engaged in completing the International Space Station (ISS), while at the same time trying to gain ground on replacing Shuttle with the new *Orion* and *Ares I* systems. Even so, *Orion* will not be operational until FY14, the last year allowed by Presidential policy guidance. It had been hoped by many in NASA, the White House, and Congress that we could deploy *Orion* as early as 2012. The later delivery of this key first element in the Exploration architecture was accepted precisely *because* no one wanted to cut the science budget in order to deploy a Shuttle replacement vehicle earlier. This was a serious and significant commitment to science at NASA, one which was made in the face of very tough issues in the human spaceflight program. That commitment implies that the United States, in the face of growing international competition, will not have a human space flight capability of its own for at least four years. This was an enormous step, and raises national issues far beyond any in science.

The above decisions are consistent with a long period of support for and growth in the portfolio of the Science Mission Directorate. Science today comprises a larger piece of the NASA portfolio than ever before; 32% today as compared with 24% back in the mid-90s.

While we will still launch a mission to Mars at every orbital opportunity, we have rebalanced what many viewed as an excessive increase – about 40% – to robotic Mars exploration, at the expense of other areas in science. Further, we have restored some cuts made previously in Earth science, and sponsored a National

Academy study to produce the equivalent of a "decadal survey" in this field for the first time. These decisions reflect a commitment by NASA to long-term balance in our science portfolio, and recognition of the key role of Earth science in that portfolio. Earth science at NASA receives \$1.5 B annually, more than 25% of our science portfolio.

There has been a strong, visible, clear intent by NASA management to restore the previously cancelled *Hubble* servicing mission, if it is technically possible to do so. A final decision and an accompanying announcement should be made by November.

In support of both National Academy priorities and long-standing international commitments, we have reviewed the SOFIA mission, restored funds to the program, and redirected the program management strategy so as to offer the greatest possibility for ultimate success, despite a history of significant overruns and schedule slips in the program.

We've completed the Earth Observing System with the recent launches of *Cloudsat* and *CALIPSO*, and will be taking part in the multi-agency NPOESS effort through our development of the NPOESS Preparatory Program (NPP). And we've recently placed the system integration responsibility for the Landsat Data Continuity Mission (LDCM) here at Goddard.

There's more, indeed much more, but my point is, I think, clear. These are *not* the actions of a science-hostile NASA, OMB, or President. Quite the contrary.

So, what's all the tumult and shouting about? A few key things come to mind, concerning which you probably won't be surprised: I think it comes down to money, respect, and power. So let's take these issues on.

First and most obviously, despite all the good things above, "Science" was in earlier years promised more than it is actually getting. I believe that what SMD is getting is pretty good, but it isn't what was promised in the FY05 budget, as that budget was unveiled in February 2004. That is a plain fact.

The other plain fact is that *no one else at NASA* is getting what they were promised either! NASA as a whole will receive fully \$3 B less than planned in the five-year runout in the FY05 budget request. But there were several "disconnects" in that plan. Shuttle and ISS were under-funded by almost \$6 B. Cross-agency support programs were significantly under-funded, and NASA was subjected to a

government-wide 1% rescission of \$350 M for FY06-07. We looked for savings where we could find them, but in the end it was necessary to reduce SMD by \$3.1 B and Exploration Systems by \$1.6 B to close the FY07 budget request.

At this point, let me add a necessary footnote to the above discussion. By "underfunded", I mean that during preparation of the FY05 budget it was assumed that, since Shuttle was retiring in FY10, the program would require less money for FY '08, '09, and '10 than would otherwise have been the case. While strictly speaking this is true, it is not nearly as *much* true as had been hoped! If we're going to fly the Shuttle at all, it turns out that we actually still need most of the program to be there for the last flight. And, of course, we've had to take \$2.7 B in Shuttle return-to-flight costs out of what little "hide" remains in SOMD. So, the Shuttle/ISS program has been reduced to 17 flights from 28. There will be little actual "utilization" of ISS for the next several years, in contrast to the original plan; we will be doing mostly "assembly". Now, of course, the science community would by and large just as soon see Shuttle/ISS cancelled outright. But at the highest levels of national government, that simply was *not* the decision that was made! So, logically, it is time to move on. But what the scientific community sees in all of this is a broken budgetary promise, pure and simple.

In this context, I have on many occasions heard the accusation that NASA has betrayed the scientific community because, it is said, the Vision for Space Exploration was "sold" as being "affordable", to be "go as you can pay". To many scientists, that means very explicitly that Exploration is to be funded after, and *only* after, *all* prior science commitments were satisfied. The idea seems to be that, after we've done JWST, Europa, SIM, TPF, and every other mission in the pre-VSE NASA budget, then and only then can we embark upon renewed human Exploration of deep space. Well, that is simply not how it works. "Affordable" does not mean that *all* of Science is of higher priority than *anything* in Exploration. The programs above were approved in an earlier time, with different budget assumptions for NASA. There have been very significant budget cuts and many unplanned requirements for funding since the Vision for Space Exploration was announced. The impact of those cuts cannot fall to any single entity in NASA's portfolio. "Go as you can pay" applies to all of NASA, not just to isolated pieces of its portfolio.

That's the "money" part of it. I've outlined the arguments not because I expect to obtain agreement – far from it – but because I think it's useful to get the nature of the issue frankly into the open. Science did not get, and will not get, as much as

was promised only a couple of years ago. Nor will anyone else at NASA. Nor will many other areas of discretionary government spending.

So now lets move on to “respect”. Once the Vision for Space Exploration was announced, the science community immediately said, as if with once voice, "Robotic science is exploration too!" Besides, 'exploration without science is tourism'! No more 'flags and footprints'!" (Which is to me, by the way, a rank mischaracterization of Apollo, but I won't fight that battle here. I will note that approximately one-fourth of Apollo funding was devoted to the last six scientific exploration missions to the Moon, missions that resulted in a profound increase in our understanding of the history of terrestrial planets, particularly the Earth, and of the environment in which it and life evolved.) I'm sure you've heard all of this and more. Since the science community had never previously characterized their work in terms of “exploration”, many observers concluded that the theme underlying these view was, more cynically, “Don't cut our budget to pay for human spaceflight!”

Now, certainly exploration includes and enables science, for it opens and offers new capabilities to do exciting new science in new ways from new places, and about those new places. What an incredible opportunity!

But, as always, there is another view, best and most tersely captured by the President’s Science Advisor, Jack Marburger, in his March '06 speech at the AAS Goddard Symposium. Jack noted that the Vision for Space Exploration is fundamentally about bringing the resources of the solar system within the economic sphere of mankind. It is not fundamentally about scientific discovery. To me, Marburger’s statement is precisely right.

So a key point must be made: Exploration without science *is not* "tourism". It is far more than that. It is about the expansion of human activity out beyond the Earth. Exactly this point was very recently noted and endorsed by no less than Stephen Hawking, a pure scientist if ever there was one. Hawking joins those, including the Chairman of the NASA Advisory Council, who have long pointed out this basic truth: The history of life on Earth is the history of extinction events, and human expansion into the Solar System is, in the end, fundamentally about the survival of the species. So to me exploration is, in and of itself, equally as noble a human endeavor as is scientific discovery.

Now, portions of the broader scientific community feel deeply disrespected – I can think of no other word – when I, or anyone, says or implies that “Exploration” is

not primarily about “Science”. There exists a view that the only reason we go into space is to pursue scientific discovery. To me, that is *a* reason, but it is certainly *not the* reason.

Scientists frequently tell me that they want to "be a part" of the Vision for Space Exploration. And that is essential. But to be a part of the VSE does not mean to collect money that would otherwise go into manned spaceflight. It means *rethinking* planned programs of scientific activity in light of the opportunities to be made available through a newly vigorous program of human exploration. That is exactly what our NASA Advisory Council is asking the community to do with its planned Lunar Science Workshop next year.

I have said on numerous occasions – many of you have probably heard me say it – that the Vision for Space Exploration is not about getting more money for manned spaceflight. It is obvious that such is not going to occur. Rather, the Vision is about *redirecting* the money that the nation has been spending on human spaceflight, but to better purposes than we have been spending it. That is the key.

Similarly, participation by "Science" in space exploration cannot be about the transfer of money into the Science Mission Directorate. It can only be about *redirecting* the money being spent in existing scientific arenas, along lines which the scientific community believes to be more productive, *given* the fact of human exploration and utilization of the Moon, Mars, and near-Earth asteroids in the coming decades. It is about *refocusing* our thoughts as to the merits and nature of future programs, *given* that humans will be operating in space beyond low Earth orbit.

This is the attitude that must prevail if there is to be respect by non-scientists for the contributions “Science” can make to exploration. And it is the attitude that must prevail if scientists are to show appropriate respect for those whose primary focus is to expand the scope of the stage upon which we humans act. If mutual respect can be developed between these two groups, they can be allies rather than adversaries in the grandest endeavor I can imagine. Scientists and non-scientists alike must remember that “exploration science” is not an oxymoron.

Finally, there is the issue of control. Many members of the scientific community fully understand that the President and Congress have made decisions about the Shuttle and ISS programs that will not be undone. They understand that the proportion of funding at NASA that goes to SMD is at an historic high, and that they should pocket their gains over the last decade and remain quiet, lest someone

notice! They understand that NASA is unlikely to grow in real terms, and that therefore many projects which all of us would like to do earlier, will in fact be done later. They get all of that.

The problem is that these folks *do* understand these real-world limitations, and in a world with such limitations, they want to be in charge of the distribution of resources. Put bluntly, they want to exercise the inherent authority of government to decide what is being done with the money which is available for science at NASA, but without having to come to Washington, put on a NASA badge, make all the associated sacrifices, and live with the consequences of their decisions, which mostly means that when you decide to do one thing, you are also deciding *not* to do something else that someone else would like to do, and you have to be publicly accountable for that fact.

This is the world of the many advisory committees and groups which rendered guidance to NASA, especially to NASA/SMD, before I became Administrator. Some of these external folks really seem to believe that NASA program selection and planning should be vetted through "the community" for approval. It is one thing to say that, broadly, we should be guided by the decadal plans of the NAS, the organization to which Congress looks for strategic advice in such matters. I emphatically support this view, while also being of the belief that sometimes, circumstances change on time scales shorter than a decade, and also that sometimes good advice comes from other directions. But it is another thing entirely to suggest that "the community" has an inherent right to review and modify our annual budget. To me, one of the most disturbing aspects of this practice is that the very same people who stand to benefit from particular distributions of NASA funding would be advising NASA as to what those distributions ought to be.

Let us for a moment consider the situation in the abstract. The market for scientific goods and services, while dominated in the space sciences by the government, is nonetheless a market like any other. So, each year the President and Congress (mostly upon the advice of scientists) determine that the pursuit of certain goals in space and Earth science is in the best interests of the United States. Each year, the Congress approves the purchase, through NASA, of scientific goods and services to that end. As with most markets, there are more parties desiring to provide such products than can be procured, and so a variety of closely supervised competitive procurement mechanisms are employed to determine the successful suppliers of these products.

Thus, from a legal, contractual, and managerial perspective, members of the external scientific community are suppliers to NASA, not customers.

My point is that if we were to substitute above any other noun besides “science”, the inherent conflict between the role of the scientific community as a purveyor of products to the government, and its role as the primary source of advice as to which products the government should purchase, would not be tolerated. Yet, the scientific community simply *must* be involved if we are to set intelligent priorities among the nation’s various scientific goals. The whole process is ethically defensible if, and only if, a proper “arm’s length” separation is maintained between advisors and implementers.

This is a very fundamental issue, a matter of organizational governance. So where, exactly, do external advisors fit into the development and execution of the NASA science strategy? Let’s review the bidding concerning NASA’s advisory committee structure.

Leaving aside temporary groups established for specific purposes, such as the committees which investigated the *Challenger* and *Columbia* accidents, legislation governing NASA includes three specific groups chartered by the Congress to advise the Administrator. These are the NASA Advisory Council (NAC), the Aerospace Safety Advisory Panel (ASAP), and the new ISS Independent Safety Task Force (ISS-ISTF). These groups examine our programs from the various perspectives suggested by their names, and make recommendations to the Administrator. Pursuant to the 2005 NASA Authorization Act, any recommendations from the latter two groups are also provided to the Congress.

I take these advisory groups, and the importance of their roles, very seriously indeed. Recommendations from our Congressionally chartered advisory groups are, and must be, considered and evaluated thoughtfully, and we at NASA must respond to them in a timely and substantive fashion, whether we choose to adopt a given idea, or not. In fact, I have sought to elevate the role of the NAC relative to that it has occupied in recent years, because of its statutory role as *the* primary external advisory group for NASA in its implementation of national space policy.

But that’s all there are. There are no other standing committees or interested parties required or permitted to review and advise NASA, no other group whose recommendations should be thoughtfully evaluated and to which the Agency must respond. Now, all of you know that there are many, many individuals and groups whose interests are affected by NASA programs and decisions, and who believe

that they deserve “a seat at the table” in helping to shape such decisions. But there is no foundation for such a belief.

Several independent groups and committees had been chartered by NASA, particularly in connection with the science advisory structure for SMD, prior to my tenure as Administrator. They are gone. Instead, a quite similar advisory structure now exists as a group of subcommittees under the aegis of the NAC. I have done this for three reasons. First, in a “strict constructionist” sense, I prefer to use the advisory structure provided by the Congress to help manage NASA. Second, mutually independent committees advising particular elements of NASA from a particular perspective can easily – I would say inevitably – offer conflicting and uncoordinated advice lacking concern for the larger perspective, with no need to resolve inherent conflicts with other portions of the Agency’s portfolio or direction. Third, it was my observation that NASA managers have sometimes used these advisory committees to assist in shaping the direction of our programs to a degree that I find unseemly, in view of the inherent potential for conflicts that I have outlined above, and in a manner tending to reduce responsibility and accountability on the part of NASA officials.

Bringing the more specialized advisory groups together as subcommittees under the purview of the NAC, which reports to the Administrator rather than to individual organizational elements within SMD, addresses and resolves these issues. This structure offers and allows frequent interchange between NASA Science Mission Directorate staff and the external scientific advisory community, but without diffusing the responsibility of NASA managers for their programs. It also allows the NAC to weigh the advice of its Science Committee, or any other of its Committees, against the perspectives and responsibilities of other Mission Directorates and other managerial units of NASA before making final recommendations to me. I believe this to be the proper way to provide an open forum for the full spectrum of advice and perspective that might be of utility to NASA, while at the same time allowing the NAC leadership to winnow and focus such advice in a manner deemed appropriate by the Council. And since the Council reports to the Administrator, formal advice to NASA follows the formal chain of command used to manage the Agency.

It has been said that in restructuring the scientific advisory committees as I have done, I have somehow “diluted” – that word from a 2 Sep 2006 New York Times editorial – the voice of the scientific community, or have otherwise attempted to stifle debate and discussion, or am trying to suppress advice that I do not wish to hear.

This is nonsense. It is simply a fact that the NAC subcommittee meetings are open to, and heavily attended by, NASA managers and key staff. Anyone who attends is instantly privy to all advice and discussion that is aired, or which is working its way through the system. An obviously good idea can be adopted by a NASA manager without waiting for a formal recommendation. The public – including the media – is present for final Council deliberation and action. There is no "dilution" of advice whatsoever. There is only the question of whether a Committee accepts a given piece of advice, whether the Council as a whole agrees with the Committee's recommendation, or whether it suggests alternative wording. Generally, the Council has gone along with Committee recommendations; the one major exception occurred when the Science Committee recommended that it be able to bypass the Council, the NAC Chair, and the Administrator, and provide "tactical" advice directly to SMD.

Let's consider this particular recommendation. How many of you present here today, and who are organizational managers at any level, would appreciate external advisors – or even other managers – bypassing you to provide "tactical" advice to those who report to you? Any takers for this approach to organizational governance? And if not, would it make a difference if the staff members and the advisors are "scientists" as opposed to other employees?

Moving on, it has also been alleged that, in reshaping the advisory committee reporting structure, I am "preventing scientists from talking to scientists". This is also nonsense. As far as I am concerned, anyone can talk to anyone, and probably should! I desperately hope that the staff of NASA's Science Mission Directorate converses widely and frequently within the community. The NASA scientific staff absolutely *must* be *of* the scientific community, and active in it, to be effective in the planning and execution of their work. But the rendering of formal advice from an advisory committee to officials of a Federal agency is hardly "scientists talking to scientists", nor should it be.

In fact, with regard to scientific advisory committee input to NASA, the real issue is not whether "scientists can talk to scientists", but whether the Administrator is to be included in the conversation! By requiring formal advice to be debated in and provided through the NAC, the scientific community's advice to NASA comes to the Administrator *and* simultaneously to the Science Mission Directorate. Under the prior structure, with numerous committees reporting directly to lower-level organizational managers, the Administrator usually had no direct knowledge as to

the advice being provided to the Agency by external groups. This is not a responsible approach to organizational management.

Thus, at this point, I am back to basic organizational management principles. Responsibility and accountability for planning and executing NASA's science program must rest with NASA's managers, not the external scientific community. Execution of these responsibilities must be appropriately informed, and to this end we must, and will, make intelligent use of our advisory committee structure. But the final responsibility and accountability for Agency programs can lie nowhere other than with us, the NASA staff.

I hope I have been able to clarify my thinking with respect to how science fits into NASA's overall strategy. I am deeply committed to having a robust science portfolio, and my actions have been consistent with that commitment.

As Administrator, I put the Hubble Servicing Mission back into our science plan. I rebalanced the science portfolio out of respect for National Academy priorities and out of concern for the health of important disciplines like Earth science and heliophysics. I did have to cut the growth rate for science, but other parts of the NASA portfolio, including Exploration and Aeronautics, have made similar sacrifices.

Others with more singular and self-interested views of NASA's purpose would like to divide and conquer us. They would like to cast the argument in the terms "Science vs. Exploration". That argument is deliberate and deceptive. I don't accept it, and I urge you to reject it as well. The Vision for Space Exploration was wise to call for the use of both robotic scientific missions and human scientific missions in the exploration of the universe. It rightly recognized the strengths of both endeavors, and it understood the symbiosis between robotic science and human exploration that will characterize our exploration campaigns.

So, this isn't about "Science versus Exploration". We will do both. And we will succeed with both. Both will contribute greatly to increased understanding of ourselves, the environment in which we live, and the solar system and universe around us. And because of the mutually reinforcing relationship between the two, we will do both better than we could do either one alone. This will be a productive partnership, and the sooner we recognize that, the better that partnership will be.

And finally, as I have said from day one, we, NASA, are responsible for executing the nation's space program. Sixteen months ago, shortly after joining NASA, I was asked if I would approve the flight of STS-114 in the face of concerns by some members of the Stafford-Covey Return to Flight Task Group. I said then that the role of advisors is to advise; NASA decides. I will no more submit NASA's scientific decision making to external committees than I submitted NASA's Shuttle flight readiness decisions to them. And I say that with no disrespect to NASA's important advisors. When they have something to say, they should say it, and we should listen and listen carefully. But in the end NASA, and by "NASA" I mean you and I, are responsible for the decisions of this Agency. And you should understand that in taking that position, I am not only committing to a certain kind of governance in which I strongly believe, but I am also demonstrating commitment to and respect for you.

Thank you for choosing to spend your time with me today.