

NASA and Commercial Space: Public Trust and Private Interest

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Good morning. I'll bet you all are just chomping at the bit, waiting to hear the details about how we at NASA are going to cope with a full-year continuing resolution for FY07, and how that will relate to the formulation of the President's Budget for FY08.

Well, me too.

But I am not here today to add to the speculation which has been going around on such matters. For now, it must suffice to say that we're consulting with the White House and our Congressional oversight committees concerning our budgets for 2007-08. We'll all learn more in February.

Nor will today's talk pursue an historical view, exploring the analogies between exploration in earlier times and today's mission of space exploration. I've done a few of those recently, because I believe that such history provides a highly relevant backdrop for decisions that our society must make, again, in a new context. But when it comes to giving "visionary" speeches, I was recently given a very strong hint in the form of a Dilbert cartoon, provided anonymously by our Strategic Investments Director, Chris Shank. In the cartoon, Dilbert's boss asks him, "How can you make good ideas sound so bad?" To which Dilbert replies, "I'm an engineer." I think that pretty much sums up the generally accepted view of my speaking ability. So with that in mind, I'm going to dispense with history today. But at some future time, I do think we should have a discussion concerning the lessons to be learned from the travails of the Donner Party.

More seriously, I think that you here at the Space Transportation Association already understand why space exploration and scientific discovery is important for our nation. So as an engineer, I would like today to discuss a long-running and important complaint about how NASA, and many government agencies for that matter, conducts its business.

There has always been a lot of rhetoric about the inefficiency of government. I find it frustrating too, and I've generated a bit of such rhetoric myself. But recently, we've seen editorials and articles in the mass media broadly urging NASA to embrace the commercial space community, and to "get out of the way" of space development. We've seen an article on how the Russians sell seats on their Soyuz flights, wondering why NASA cannot do the same. We've been told that our Earth-to-orbit transport problems will be solved if we just hand our requirements to Burt Rutan. We've been urged to put up "half of the NASA budget" as a prize

for unfettered industry to return us to the Moon. And even our own trade press is questioning why it will take us fifteen years to get back to the Moon, when it was done in eight years the first time, and urging us to make greater use of commercial industry to speed up the process. So, with this as background, I would like to take a few minutes this morning to address what I believe are some fundamental misconceptions about the role and limitations of government, and to do so in what I hope is a more thoughtful manner than can be achieved with bumper-sticker quality one-liners. Perhaps you and your member companies can help NASA and our stakeholders by informing the debate as to how you think we can better conduct our business.

So, let me acknowledge that, yes, government is not usually very efficient. I am sure that you are shocked – shocked – to hear this. And while I like to think that we really try to do our best, NASA is part of government. Now, because resources are very tight, because we cannot expect to get any more money, and because we desperately want to move out on lunar and Mars exploration, we're paying a lot of attention to this matter. So let me tell you about a few of the things that we're doing to run NASA as efficiently as we can.

We must first be clear on what we mean by "efficiency". Government agencies do not generate profits, and should not, since we should never compete with private industry. When technology reaches a point that an activity can become profitable, as communication satellites did or as many functions once performed exclusively by the U.S. Postal Service have, the activity should be performed by private industry. The government should develop and provide services and capabilities for the common good, where the market cannot. For NASA this means that we explore space, conduct scientific research, and develop technologies that improve our ability to utilize air and space. Our measure of efficiency is to accomplish a given technological objective within given cost or schedule constraints. In the 1960's we were asked to send humans to the moon and return them safely to Earth within that decade. The NASA of that era accomplished that goal in a manner that I believe was very efficient. Today we are asked to complete the very complex assembly of the space station by 2010, return humans to the Moon not later than 2020, and then to send humans to Mars and beyond. We are asked to conduct scientific investigations and to meet engineering goals that will improve our understanding of the Earth and space and enhance our national competitiveness. We are asked to do all of this on a go-as-you-pay budget. So efficiency in today's NASA lies in what we can accomplish within the budgets we are provided. To do this, we must understand our mission priorities, focus on life cycle costs, sponsor partnerships with the commercial sector, and pursue partnerships with the international community. In this way we will maximize the value of every dollar spent to meet our objectives.

Shana Dale, Rex Geveden, Paul Morrell, and I have sponsored an internal "Mission Focus Review", looking into our mission support areas for ways to focus our activities toward the highest priority tasks at hand. Quite simply, our view is that NASA as an institution should stop doing those things which have grown up within the agency during less focused times, things that do not directly contribute to our mission. This is not an approach to doing more with less; we simply need to do less. We need to eliminate activities which are less important, in favor of those which are more important.

To that end, we need to have technically strong, but numerically smaller, project offices in our mission directorates, with the necessary autonomy to carry out their assigned missions and to assure that NASA, as an institution, retains the intellectual property necessary to sustain this long journey of space exploration and scientific discovery.

We all know that significant cost reductions on a given task are only possible if we can reduce labor costs. There are few savings to be had in the cost of raw materials. Our tooling and manufacturing processes are largely dependent on the technology of a given era, and thus are not commonly subject to short-term improvements. So, unless we all want to work for lower salaries, we must turn our attention to the number of people we allocate to doing a job.

Here is where I believe there is enormous leverage to be had. First and absolutely foremost, we need to manage our spaceflight projects and programs in such a way so as not to cause, or allow, either government or industry managers to allocate people to tasks that do not add value to the mission at hand. Government managers need to prevent proper oversight from crossing the line into micro-management. We must understand that when we pose questions to contractors, we will get answers – but at a cost. Thus, we need to be judicious in our requests for information and contract deliverables. This is a delicate balance requiring good judgment on the part of the program managers so that we obtain what the government should have, yet without expending resources to produce deliverables that no one ever uses.

Additional leverage lies in defining the requirements for new missions. We have recently completed several System Requirements Reviews for certain Constellation program elements, and I am reminded again that the best rule of thumb for specifying requirements is that NASA managers should, to the extent possible, specify performance requirements and let industry teams propose how to meet those requirements. Management at any level consists of specifying “what” and reviewing “how”. Now, most of us know quite well that scientists and engineers on the government side of the house have an overwhelming urge to specify the design to meet a requirement, and unfortunately we also have the power to gratify this urge. We need to overcome this bad habit, unless we know with certainty that must have a specific approach, in which case we should then clearly say so, and allow the contractor to move on. Further, we must be disciplined in not allowing “desirements” to creep into the system as time marches on. We’re trying to make a new start with the Constellation program. Jeff Hanley and his team did an exceptional job in streamlining the Orion procurement, and there will be more of that to follow.

The points I made earlier go to the affordability of our missions, an essential attribute in view of Norm Augustine’s observation that, in the post-Apollo era, all NASA missions are “go-as-you-pay”. Times have changed, and large sums of additional money are unlikely for the Agency. Thus, NASA and our industry teams must design missions for the minimum total life cycle cost, not simply the minimum DDT&E costs. The NASA Authorization Act of 2005 requires us to report annually to the Congress on programs with life cycle costs greater than \$250 million. The desire for a lower life cycle cost was the primary reason why, after our Exploration Systems Architecture Study in 2005, we switched to the RS-68 and J-2X rocket engines for our Ares launch vehicles. Even though the DDT&E costs are greater for the RS-68 and J-2X engines than the modified Space Shuttle Main Engines originally proposed in ESAS, this investment will pay huge dividends when those engines are used operationally.

With “go-as-you-pay” in mind, we must be mindful that “time is money”, especially during the development phase of our programs. While we sometimes have legitimate reasons to push the state of the art in certain technology areas for a mission, we need to be disciplined in doing so, and to encourage the use of off-the-shelf and commercial hardware in those areas where we don’t need to push the state-of-the-art. When a delay is incurred as a result of trying to incorporate an immature technology, the whole program and the standing army supporting it are must wait, and costs will escalate. We need to rein in the number of technical miracles we think are necessary for a given program, and exercise schedule discipline in order to control costs. For example, we have already experienced substantial cost growth on the James Webb Space Telescope, in significant measure due to the number of new technologies being incorporated into this mission. Going forward, this situation will require continued vigilance on the part of our management team. A program without schedule discipline is, quite simply, undisciplined.

When cost is the issue, it makes sense to pay attention to the high cost items. As members of the Space Transportation Association know well, the cost of transportation to orbit is still, fifty years into the Space Age, the single largest single barrier to the utilization of space. Now, most of you will recall the high level of enthusiasm for commercial space endeavors during the mid-1990s. Most of them have not materialized. We should temper our optimism, our irrational exuberance even, for commercial space endeavors today with the lessons learned from that period. The collapse of the hoped-for commercial launch market, and consequent higher launch prices for the remaining government customers, are due not to the need for new technologies, as some have said, but for a stable market. With the completion of the International Space Station, NASA can for the first time offer such a market. And if so, maybe we can gain some efficiency through the use of alternative contract mechanisms.

The last time I spoke before the STA, I announced NASA’s plans for entering into Space Act Agreements for commercial crew/cargo demonstrations for International Space Station logistics, to be followed, we strongly hope, by commercial service purchases. One of the things I noted, a bit tongue-in-cheek, was that in the summer of 2005 this really ought not to be big news! U.S. Government outlays were then about \$2.5 trillion in a domestic economy of \$13 trillion. Even in the large, the Federal government accounts for only a sixth of the nation’s commerce. And even this figure is deceiving; most government spending involves transfer payments rather than procurement activities. All discretionary spending in FY06 was less than \$900 billion. So NASA, with only \$16.8 billion, or 0.6% of annual spending for the Federal government, is hardly noticeable based solely on its size. Most of the nation’s economy is driven by commercial rather than government interests, and I believe that most of us are thankful for that. In that context, NASA’s announcement that its preferred approach to meeting ISS logistics requirements would be through commercial purchases can hardly be considered “non-traditional”. The vast majority of our economy is fueled by such commercial transactions.

But “traditional” in the economy at large is not “traditional” in the aerospace and defense sector, including NASA. This sector is dominated by large negotiated purchases – “prime contracts” – for special-purpose hardware and services, where customer and supplier occupy a close and mutually dependent relationship. This is the world of government requirements and interface control documents and specifications, of customer oversight and contract deliverables,

of milestones and progress payments, of award-fee contracts and overruns and schedule slips and nearly interminable arguments about whose fault it all was. NASA funnels 85% of its appropriated funding to industry, most of it in this manner, and it could not be farther from the norm for the overall U.S. economy and its commercial, “arms length” transactions. Given a reasonable choice, I believe that few of us would prefer to conduct business as we in the government aerospace and defense sector so often must do. To appreciate the pitfalls inherent to special-purpose, negotiated contracts, I ask you to consider just one familiar example. Have any of you ever had a custom home built? Or had a friend or relative who did? Or remodeled your kitchen, or bathrooms? How did it turn out? Are any of you anxious to repeat the experience? How would you like to buy a car that way? ... I didn't think so, actually.

So, if those of us who've spent our lives doing it can see the obvious problems with government procurement mechanisms that are “traditional” in the aerospace and defense sector, but nowhere else, how did we get into this mess, and why do we stay there? It is here that I think a bit of perspective is in order. I can offer none better than Stephen Johnson's text, *The Secret of Apollo*. Steve takes the reader through the history of systems management, the discipline which evolved to help us deal with negotiated contracts for the development of large, complex systems. And, for balance, I can offer nothing better than *Faster, Better, Cheaper*, Howard McCurdy's treatment of NASA's reaction to the excesses of systems management. Both are available through the NASA History series.

Considering these excesses, many people have asked me: why can't NASA operate more like a business? Why can't NASA simply hand a set of requirements and money over to commercial space companies? These are excellent questions, and the answers require careful consideration. Indeed, I just spoke about many things that we are doing to manage the Agency in a more business-like way, and how some inefficiencies are accepted to ensure good program management of large, complex engineering projects. While I consider myself a proponent of commercial space endeavors, many other proponents tend to gloss over the difficulties of systems engineering and program management of complex systems in favor of ideological ideals as to how government should act more like commercial enterprise. I am concerned that those proponents have not considered either the technical or public policy issues along with the business case behind many of their assertions. So, let me address some of those.

First, I hope that NASA is not in the business of reinventing the wheel or ensuring “big government” solutions to space exploration. If you think that I'm wrong, please tell me; believe me, we'll pay attention. We are tasked by our Federal government's elected leadership to develop certain capabilities for aeronautics, space exploration and scientific discovery. I hugely admire the achievement of Burt Rutan and his team with the *SpaceShipOne* suborbital flights in 2004, and I certainly consider Burt to be a friend. But I think that it is difficult to extrapolate the success of *SpaceShipOne* to NASA endeavors. The energy which must be harnessed to launch *SpaceShipOne* to suborbital heights is about 2% of what is needed to get into low-Earth orbit, let alone carry out missions to the Moon, Mars, and other planets. This matters.

Another major difference between entrepreneurial space endeavors such as *SpaceShipOne* and government efforts involves funding. NASA, like other Federal agencies, requires public stakeholder support to carry out the missions assigned, which are incrementally

funded in the annual appropriations process. While we have learned many lessons from the X-Prize for our own prize program, and are learning how to leverage commercial space interests, Burt will admit that he only had one stakeholder to whom he answered, Microsoft founder Paul Allen. As a public institution, we at NASA have hundreds of stakeholders to whom we must answer. I have addressed the role of stakeholders and advisory committees in other speeches, so I won't bore you with that topic here, but suffice it to say that we have a fundamentally different model for both goals and governance than does a privately funded entrepreneurial company. These fundamental differences between public and privately funded space programs must be better recognized by those who advocate that NASA should conduct its missions according to the tenets of entrepreneurial space enterprises.

Now, I do not want anyone to leave with the impression that I am diminishing the accomplishments of *SpaceShipOne* or the management team behind it. Far, far from it. What an incredible accomplishment! Indeed, I look forward to the day when NASA can purchase seats on future commercial suborbital flights for our own microgravity experiments and astronaut training. All I am saying is that we need to put such accomplishments in perspective, learn from them, but not attempt to overstate the case as to how NASA should behave more like a commercial or entrepreneurial endeavor.

Strictly as an aside, I will observe that government *can* behave with the speed and efficiency of the best entrepreneurs our country has nurtured. There is more than ample evidence to support this view. The people who worked on the Manhattan Project, on the development of the ICBM and the Polaris submarine, on the P-51 or SR-71 or F-117, on Mercury, Gemini, Apollo, and Skylab, on the early SDIO flight tests, need apologize to no one. When we in the United States believe that our interests are threatened, we can move to deal with the problem at stunning speed, to the consternation of many real and potential adversaries in our history. But such efforts require conveying a degree of authority and autonomy to government managers that, in our society, is not normally allowed. Indeed, almost every aspect of the Federal Acquisition Regulations (FAR) is designed to limit the authority of government managers; in normal circumstances, we are far, far more concerned about the *possible* abuse of power than we are about the *certain* waste of time and money.

To this point, another major difference between commercial businesses and NASA is that a private concern has the luxury of "cherry-picking" its vendors. The cycle time in requesting bids, selecting a suitable vendor, awarding a contract, and making other procurement decisions is much shorter than is possible with government agencies like NASA, where we mostly follow the FAR (with the notable exception of Space Act Agreements and grants) to ensure fairness in our source selections. Now, as I have noted, the government in general and NASA in particular can certainly reduce its decision time. We seldom choose, or are allowed, to do that. Indeed, the Federal procurement process has numerous built-in mechanisms to slow down or even halt the process in order to ensure fair and impartial consideration by the government of industry bids. While I am generally opposed to sole source procurements because competition, if real, can lower the overall cost to the government, I do believe that NASA should consider certain sole-source procurements when we know in great detail what we want, and can justify the unique capability of a vendor in terms of cost, schedule, or technical advantage.

Even apart from procurement regulations, because of the scale, complexity, and risk of some of the projects we undertake, prudence may still dictate acquisition strategies more in line with traditional systems management than purely commercial practices. We must remember that systems management, as a discipline, evolved to manage complex research and development efforts such as ballistic missiles systems. For projects in which mission success has a higher value than cost control, our acquisition standards and practices will tend to be conservative. NASA simply cannot be seen as making foolish choices with other people's money.

So, while efficiency is an important metric for success, it is not the only measure that is applied to government programs. Of course, NASA can be more businesslike in its operations. However, I firmly believe that space exploration, scientific discovery, and aeronautics research requires a multi-generational approach to sustain it. NASA was founded as a public institution, must carry out its programs while operating under the oversight of our stakeholders in the White House and Congress, and must assure the long term success of its mission. In contrast, contractors and businesses come and go; they succeed or fail depending on how well they react to their markets. Hence, the need for government ownership of the intellectual property that sustains our missions will be with us as long as there is a government.

And yet, we must balance that reality with another. A measure of NASA's success in carrying out the exploration of space is the extent to which we architect the program to help create a viable commercial space industry, which we can then leverage to obtain increased efficiency in achieving our own goals.

So my thesis here today is that, while we tolerate large inefficiencies in government acquisition in order to protect other values, nevertheless we would prefer more customary transactions if we could get them. Thus, while the business of spaceflight is still dangerous for people and uncertain even for cargo, and while it has very high barriers to entry, I nonetheless believe that the time has come for the government, and especially NASA, to make the investment in commercial transportation services that we are doing with COTS. Yes, it is a risky investment, but one with potentially a very high payoff, and thus a risk worth taking at this time. It will, I hope, set a trend for more such "non-traditional" procurements of space goods and services.

I don't think the commercial space community will find a more sympathetic ear than that of the current NASA management team. This team knows the importance of carefully balancing public trust and private interests. So, the next time you are tempted to wonder why we at NASA can't move faster, or cannot do some apparently logical thing, please consider some of the points I've raised here today. Yes, surely we can do better, and we are trying. Help us with that, by bringing us your ideas. But remember also that the frustrating constraints on government development programs are the result of conflicting public policy considerations that, quite deliberately, yield emphasis on numerous societal values to which we are more strongly attached than we are to that of pure market efficiency.

And here is my final bit of advice to the space community when coming forward with good ideas for us: emulate Dilbert, and talk like an engineer.