NASA'S FISCAL YEAR 2006 BUDGET PROPOSAL

HEARING

BEFORE THE

COMMITTEE ON SCIENCE
HOUSE OF REPRESENTATIVES

ONE HUNDRED NINTH CONGRESS

FIRST SESSION

FEBRUARY 17, 2005

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February 17, 2005

NASA'S FISCAL YEAR 2006 BUDGET PROPOSAL

THURSDAY, FEBRUARY 17, 2005

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE,
Washington, DC.

The Committee met, pursuant to call, at 10:06 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Sherwood L. Boehlert [Chairman of the Committee] presiding.

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, DC 20515

Hearing on

NASA's Fiscal Year 2006 Budget Proposal

Thursday, February 17, 2005
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

WITNESS LIST

The Honorable Fred Gregory
Deputy Administrator,
National Aeronautics and Space Administration

Accompanied by:

Mr. James L. Jennings
Associate Deputy Administrator, Institutions and Asset Management

RAdm. Craig E. Steidle, USN (Ret.)
Associate Administrator, Exploration Systems Mission Directorate

Mr. William F. Readdy
Associate Administrator, Space Operations Mission Directorate

Mr. Alphonso V. Diaz
Associate Administrator, Science Mission Directorate

Dr. Victor Lebacqz
Associate Administrator, Aeronautics Research Mission Directorate

Mr. Steve J. Isakowitz
Comptroller, Office of the Chief Financial Officer

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Should you need Committee materials in alternative formats, please contact the Committee as noted above.

HEARING CHARTER

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

NASA's Fiscal Year 2006 Budget Proposal

THURSDAY, FEBRUARY 17, 2005
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On Thursday, February 17th at 10:00 a.m., the Committee on Science will hold a hearing on the National Aeronautics and Space Administration's (NASA) Fiscal Year (FY) 2006 budget proposal. The hearing will examine NASA's plans and programs and the rationale for the funding levels proposed in the agency's budget.

In January 2004, the President announced a new *Vision for Space Exploration.* The President's plan can be seen as having three distinct, but related aspects. The first aspect concerns current human space flight programs. The President proposes to complete construction of the International Space Station (ISS) by 2010 and to retire the Space Shuttle at that point. ISS research is to be reconfigured to focus on questions related to the impact on human health of spending long periods in space. Under the proposal, the U.S. participation in ISS is slated to end around 2016, although the Administration has said that that date may shift. NASA has also decided to cancel the Shuttle mission that was needed to keep the Hubble Space Telescope in operation past 2007. Completing construction of the Space Station by 2010, enabling the Shuttle to be retired that year, is necessary to free up the funds needed to return to the Moon by 2020.

The second aspect of the Vision concerns new medium-term goals for human space flight. The central goal is to return humans to the Moon between 2015 and 2020. To do this, NASA will develop a new Crew Exploration Vehicle (CEV), which will be tested without carrying people by 2008 and will carry humans into space by 2014.

The third aspect of the Vision concerns long-range goals for the years past 2020. The entire plan is geared toward preparing for this period, but what will happen during these years is (perhaps necessarily) left entirely open-ended. The ultimate goals are to send humans to Mars and "worlds beyond" and to increase the commercial exploitation of space. The timing of future exploration is left open and will depend on the pace of technology development and discovery and the availability of funds.

Overarching Questions:

Questions about the budget proposal basically fall into three categories:

1. SHUTTLE AND STATION: How will NASA ensure that the Shuttle is retired by 2010? Will that require scaling back the Space Station? How will the Space Station contribute to Space Exploration?
2. IMPLEMENTATION OF THE EXPLORATION VISION: When and how will NASA determine the specific goals for the CEV? Will the development costs of the CEV stay within budget projections?
3. OVERALL NASA BUDGET: To what extent should other portions of the NASA budget (Earth Science, Space Science, Aeronautics) be cut to free up funds for human space programs? What would the impact be of the proposed cuts in these areas?

Witness:

Mr. Frederick D. Gregory is the NASA Deputy Administrator. He is expected to be named Acting Administrator once the resignation of Sean O'Keefe is officially effective on Feb. 18.

Budget Highlights:

NASA's budget request for FY06 is $16.5 billion, an increase of 2.4 percent over the $16.1 billion provided in FY05. (The FY05 level does not include the $126 million emergency supplemental provided to fix facilities damaged from last year's hurricanes.) While this year's increase for NASA is larger than that for most other agencies, NASA's overall the budget is $546 million less than the 4.7 percent by which its budget was projected to grow in last year's budget documents.

The *Vision for Space Exploration* continues to be the priority in NASA's budget. The Space Shuttle and Space Station continue to bulk large in the budget, together accounting for 39 percent of the proposed NASA budget for FY06. Development of the CEV would jump in the FY06 budget by more than 500 percent, from $140 million in FY05 to $753 million in FY06, as work on the vehicle gets underway in earnest to allow for an unmanned test in 2008. In general, no element of NASA's budget related to exploration is proposed for a cut in FY06 for reasons of budget stringency, although a few areas are cut either because new cost estimates are lower than previous "placeholder" numbers or because of problems with specific projects. The primary example of the latter is the reduction in Project Prometheus, which is working to develop nuclear propulsion techniques. NASA has decided not to move ahead now with the Jupiter Icy Moons Orbiter (JIMO) as a first test of Project Prometheus technology because it was proving to be too complex and expensive. NASA is reviewing options before deciding what mission to substitute for JIMO as a test. Funding for research aboard the Space Station is proposed for a cut as NASA reorients the program toward research on human physiology.

The budget does propose cuts to programs that are not related to the Vision, including Earth Science, Aeronautics and some portions of Space Science. The proposed cuts in these areas along with a reassessment of NASA's personnel needs for exploration is leading NASA to consider reducing its workforce by as many as 2,000 people, through layoffs if necessary.

A Senate-requested study by the Congressional Budget Office last year determined that if costs for the Exploration Vision grew at the same pace as costs for previous NASA projects, the Vision could cost as much as $32 billion to $61 billion more than has been estimated by 2020. CBO did not assess the likelihood of such an escalation occurring.

In FY05, as part of the Omnibus Appropriations Act, Congress provided NASA with its full funding request, an increase of more than five percent from FY04, and gave NASA flexibility in allocating the money. The Appropriations Act did seek to limit spending on the Lunar Robotic Orbiter, scheduled to launch in 2008, but NASA has chosen to provide full funding for the project. The Act also provided funding for a robotic servicing mission to the Hubble, which NASA is now canceling. Congress has not yet had a specific vote or debate on the President's Vision, and the report accompanying the Appropriations Act asked for numerous reports to fill in details about the Vision.

Issues:

When will the Space Shuttle return to flight? The Shuttle is currently slated to return-to-flight in May or June of this year, after having been grounded for more than two years since the Feb. 1, 2003 loss of the *Columbia.* NASA has been working to implement the recommendations of the *Columbia* Accident Investigation Board (CAIB) and its efforts are being reviewed by a NASA-appointed group, the Stafford-Covey Task Force. The Task Force has determined that, so far, NASA has successfully completed work on six of the CAIB's 15 recommendations for returning to flight. NASA officials and the Task Force appear cautiously optimistic that NASA will be able to stick to the May-June schedule even though NASA will probably not have developed a repair capability for the Shuttle's tiles by then. NASA officials and Task Force members have expressed concern, however, that NASA could learn of problems during a successful first flight that could complicate future launches. The Shuttle will be under intense scrutiny during that flight, and since the *Columbia* disaster NASA engineers have learned of more aspects of Shuttle flights that need to be monitored (like the foam shedding that brought down the *Columbia*) because they could imperil the vehicle. NASA estimates that returning the Shuttle to flight will cost about $762 million more in FY05 than had been requested originally.

How many more Shuttle flights are needed to complete the Space Station? NASA has flown 16 Shuttle missions to the ISS so far and currently estimates that another 28 are needed to complete its construction. Doubts have been raised inside and outside NASA that 28 flights could be competed in time to retire the Shuttle by 2010. As a result, NASA is in the process of reviewing its options to reduce the number of flights (see more below), including by scaling back the Space Station and

by using other vehicles for logistic and crew missions for which the Shuttle is not required. NASA officials have suggested that the number of flights could be reduced to 23 and perhaps to as few as 16 with changes to the Space Station. Also, the Shuttle is required to ferry large replacement parts to the Station, such as gyroscopes, as they wear out. If the Station is to remain in use until around 2016, the Shuttle will have to launch and pre-position in space, large replacement parts before the Shuttle is retired.

What is the future of the Space Station, and how will it contribute to the program to go to the Moon and Mars? The President's Vision called for research on the Space Station to be reoriented from a range of biological and physical research projects to a narrower, more focused agenda researching matters necessary to keep humans alive and healthy during long stays in space. NASA now expects to have a review completed by the end of this month of how the Station could contribute to space exploration. The two greatest human health issues involve the effects of low gravity and the effects of radiation. Radiation research is better conducted on Earth than on the ISS, and NASA has a facility for that purpose at the Brookhaven National Laboratory in New York. The question then is what kinds of research can be done on the Station to learn how to mitigate the effects on the body of low gravity and whether that research can be conducted only on the Station. A related question is whether enough astronauts can serve on the ISS long enough for statistically sound conclusions to be reached before the Station is retired. NASA is seriously considering scaling back the Station to eliminate projects that may not be required to understand how astronauts could spend long periods on the Moon. NASA may cancel the centrifuge being built for the U.S. by the Japanese that was to study the effects on animals of low gravity. While in the past, the centrifuge was described as perhaps the most useful piece of scientific equipment designed for the Station, NASA is now beginning to argue that it needs human rather than animal research and that the centrifuge research is more relevant to a Mars mission than to a lunar one. Once NASA determines how it will use the Station, it will then determine how many Shuttle flights will be needed to complete the Station and when they will be needed. That review is expected to be completed late this spring.

Will Americans still be able to use the Space Station effectively after next April when our agreement with the Russians expires? NASA faces a legal hurdle next year that could prevent any effective utilization of the Space Station after next April. The U.S. is dependent on the Russians for crew rescue capability, which is provided by Russian Soyuz vehicles. The Shuttle is not capable of remaining docked at the Station for long enough stays to provide this service, and U.S. regulations prevent astronauts from being aboard the Station if there is no rescue capability. But under the Iran Nonproliferation Act (INA), the U.S. is forbidden to provide the Russians with cash or services under a new agreement unless the President certifies that the Russians are not proliferating nuclear technology from Iran—a certification the President is highly unlikely to make. NASA has no known alternative plans for providing a crew rescue capability beyond buying such services from the Russians. The matter is currently the subject of an interagency review, and the Administration is expected to send up an amendment to the INA, perhaps as early as next month. It is unclear how Congress would react to such a proposal with Iran being such a focus of attention in foreign policy. The International Relations Committee, which shares jurisdiction with the Science Committee over the Act, has been a strong proponent of the Act. If Congress fails to amend the INA, the U.S. would not be able to use the Soyuz as a rescue vehicle or to use Russian Soyuz and Progress vehicles to ferry astronauts and cargo, respectively, to and from the Station to limit the use of the Shuttle.

Will the Space Station program exceed the Congressional cost cap? Another legal hurdle facing the ISS program is the $25 billion cost cap for ISS development set by Congress. (The cap only applies to ISS development costs and does not include costs for operations, Shuttle, and research.) The original cost estimate for ISS development in 1993 was $17.4 billion. In 1998, NASA announced an increase to $21.3 billion. As a result, NASA asked an outside task force to evaluate the cost and schedule credibility of the ISS program. The task force estimated the development cost of the ISS, given the configuration at the time, at $24.7 billion. Congress then set a $25 billion cost cap on the ISS in the *NASA Authorization Act of 2000* (P.L. 106–391). According to NASA's FY06 budget request, the ISS will exceed the Congressional cost cap in FY05. NASA is likely to request legislative relief from the existing cost cap.

How is NASA proceeding with development of the CEV? NASA intends to issue a Request for Proposals for companies interested in developing the CEV in

March. Then toward the end of FY05, NASA intends to select two teams to prepare prototypes of a CEV. As a result, large-scale spending on the CEV is slated to begin in FY06. NASA has described its budget request for CEV for FY06 as something of a "placeholder" because no contract has yet been let. NASA has estimated total development costs for the vehicle at about $15 billion. NASA is moving ahead with contractor awards without settling many of the questions concerning the vehicle, and, indeed, will leave some of these questions to two contractor teams that will design the vehicle. Among the key open questions are whether the CEV will be able to dock with or service the Space Station and the number of crew members it will be able to carry. Relatedly, NASA has not yet decided what astronauts will do once they get to the Moon. Some of those decisions will have to await the data gathered by the Lunar Robotic Orbiter, due to be launched in 2008, which will gather data on potentially landing sites and the availability of resources on the Moon, including water.

What launch vehicle will the CEV will require? NASA has also not yet decided what vehicle to use to launch the CEV. It could choose to launch the CEV into space on top of an expendable rocket like the Defense Department uses to launch satellites, although alterations might need to be made to such a rocket for it to be considered sufficiently safe for human launches. Or NASA may choose to develop a launch vehicle based on the components of the Space Shuttle. Alternatively, it may choose to develop an entirely new vehicle, although that would probably increase the costs for the Vision beyond current estimates.

NASA must make a decision soon, especially if the agency chooses a Shuttle-derived design, because it must work to keep open production lines for Shuttle components beyond the point when they would otherwise be needed. The President's recently released Space Transportation Policy directs that NASA's decision be made jointly with the Department of Defense. NASA anticipates that it will conclude its study of launch vehicle options and submit its decision for interagency review sometime in the next few months.

How will the Vision affect NASA's science and aeronautics programs? NASA considers planetary science (such as robotic missions to Mars) as part of the exploration program. But other areas of Space Science, such as those more related to astrophysics, and all of Earth Science are not considered NASA priorities in the FY06 budget, although they continue to receive significant funding. The proposed changes in these areas are highlighted in the budget details in the next section of this charter. The FY06 budget calls for a significant paring back of aeronautics research, refocusing the program, and reducing funding to $850 million, down $250 million from FY04. NASA has requested adequate funding to preserve the launch date of 2011 for the James Webb Telescope, the successor to the Hubble Space Telescope.

What is the future of the Hubble Space Telescope? The budget request, in effect, allows the Hubble Space Telescope to die, as funding is included only to continue work on a de-orbiting mission; no funds are included for servicing. The Committee recently held a hearing to examine the options for the Hubble, of which there are basically four, each of which arguably cost in the range of $2 billion:

- Do not service the telescope. The telescope will then cease to function as early as 2007. NASA does have other space telescopes in orbit and others are planned to be launched in 2011, but none has the same capabilities as Hubble.
- Send the Shuttle to service the telescope. This is the recommendation of the National Academy of Sciences. Like any Shuttle mission, this would put astronauts at risk. It would also delay completion of the ISS.
- Send a robotic mission to service the telescope. There is wide disagreement as to whether this mission could be ready in time. The National Academy of Science concluded it could not, but those involved in the robotic effort believe it can be done in time.
- Launch a new "platform" with the equipment that was designed to be added to the Hubble (this is sometimes called "rehosting") and perhaps include new equipment as well. This would leave a gap in Hubble science, as the new platform would probably not be ready until after the Hubble stopped operating.

Details of NASA's FY06 Budget:

Comparison of NASA's FY06 Budget Request with Prior Years' Budgets

Program	FY 2004	FY2005 NASA (Op Plan)[1]	FY 2006 (Projected)[2]	FY 2006 (Proposed)	Change FY 2006 (Projected) to FY 2006 (Proposed)	Change FY 2005 to FY 2006 Proposed
Science	5,584	5,527	5,794	5,476	-318	-51
Exploration Systems	2,631	2,685	3,529	3,165	-364	480
Aeronautics	1,034	906	957	852	-105	-54
ISS and Space Shuttle	5,443	6,219	6,090	6,388	298	169
Other (Flight Support, Education, and IG)	686	733	632	575	-57	-158
Total	**15,378**	**16,070**	**17,002**	**16,456**	-546	386
Emergency Hurricane Relief Funds		126				

All amounts are in millions of dollars.
[1] Amounts listed are those included in NASA's initial operating plan for FY2005 and are thus subject to change throughout the year as NASA identifies changes in program needs.
[2] Amounts listed are those projected as NASA's needs for FY06 in the President's FY05 budget documents.

Space Operations

The primary programs within Space Operations are the ISS and the Space Shuttle, which together make up almost 40 percent of NASA's budget. The FY06 budget request for ISS and Space Shuttle totals $6.4 billion, up $169 from FY05 and $945 million from FY04.

Funding for the Shuttle would decline from nearly $5 billion in FY05 to $4.5 billion in FY06 as NASA finishes paying for the increased costs associated with returning the Shuttles to flight. NASA says that it will not know whether it will need to make adjustments to its FY06 request for Shuttle until after the Shuttle returns to flight and the agency can assess whether additional work must be done to ensure the vehicles' safety. Also, NASA has indicated that the funding levels proposed for the years beyond FY06 (see attached table) are ballpark estimates and could rise as NASA develops a better understanding of the costs associated with retiring the Shuttle.

The large increases in the Shuttle program from FY04 to FY05 were due to the escalating costs of returning the Shuttles to flight, expected this spring. The current launch window for return-to-flight is May 12th through June 3rd.

Exploration Systems

Funding for Exploration Systems—which includes funding for the human Moon mission, including the CEV, and for the development of nuclear reactors for use in space and on other planets—would grow by nearly half a billion dollars from FY05 to $3.165 billion under the request. The CEV would grow from $140 million in FY05 to $753 million in FY06. Meanwhile Prometheus, NASA's nuclear reactor program, would be cut from $432 million in FY05 to $320 million in FY06.

The Administration has described its FY06 request for the CEV program as something of a "placeholder" while the program continues to be defined. The funding level requested for Prometheus is a placeholder, as well, as NASA recently announced that it was scrapping its plan to send a nuclear-powered robotic mission to Jupiter's icy moons (an orbiter known as JIMO) and is instead conducting a complete review of its nuclear program. The agency says that the analysis will help it to determine how Prometheus might fit into the Vision and what kind of mission might provide the best opportunity to demonstrate its capabilities. In the meantime, JIMO is on hold, sidelining a mission that included investigations of the Jovian moon Europa, the number one priority among scientists, according to the latest National Academy of Sciences decadal survey of astronomy priorities.

The budget requests $34 million for NASA's prize program, called Centennial Challenges, up from $9.7 million appropriated for FY05. NASA needs authorization from Congress to move forward with prizes greater than $250,000.

NASA proposes to shift into the Exploration Systems account what was previously the Biological and Physical Research (BPR) program, now called Human Systems Research and Technology. The program funds research aboard the ISS. The program has been restructured numerous times over the past several years. The budget proposes a $198 million or 20 percent decrease from FY05 levels to $806 million as NASA determines the future of the program.

Science

Funding for Earth and Space Science programs, which NASA proposes to combine into a single Science account for FY06, is only slightly down from FY05, but several hundred million below the level NASA projected last year that it would need. To accommodate the addition last year of the Lunar Reconnaissance Orbiter (LRO) mission, which will orbit the Moon to gather data in advance of a human mission, a number of Space Science and Earth science programs have been delayed or cut. As the LRO mission ramps up the amount of funding required, it is expected to have a larger effect on other space and Earth science missions unless the overall level of funding for science grows accordingly.

Last year, NASA announced that it would delay the launch of the Joint Dark Energy Mission (JDEM), a mission NASA had planned to carry out together with the Department of Energy to explore the nature of dark energy. Scientists believe that understanding dark energy has the potential to fundamentally alter our understanding of the universe.

The following are changes NASA proposes to make in this year's budget:

- Cut to Earth Science: The budget cuts the Earth Systematic Missions program by $118 million, or 40 percent below FY05. As a result, NASA proposes essentially to cancel the Glory mission, which the Administration believes will answer critical questions about climate change. While the budget continues the Global Precipitation Measurement (GPM) mission, it is not clear whether enough funds are provided in FY06 to allow for the planned 2010 launch. Earth scientists have called GPM one of their top priorities for understanding severe weather events such as hurricanes.

  Also, a mission designed to ensure that weather instruments are properly tested before they are launched on the Nation's next generation of weather satellites is running into problems and will be delayed if it does not receive additional funding.
- Addition to Earth Science: The budget increases funds for Earth System Science Pathfinder projects by $27 million, or 25 percent over FY05. However, the budget documents NASA has provided do not contain sufficient detail to determine which programs will benefit from the increase.
- Change to Space Science: The proposed budget provides $371 million for the James Webb Space Telescope. NASA continues to hold to a launch date of the Webb to 2011. The budget for Webb is an increase of $60 million over the FY05 level, but a $23 million decrease from the level projected for FY06 last year. It is unclear why NASA now believes the Webb Telescope needs less than it had previously projected.
- Cut to Space Science: The budget proposes slipping the Space Interferometer Mission (SIM) by two years with launch now scheduled for 2012. SIM will detect Earth-like planets.
- Cut to Space Science: The Future New Frontiers program is cut by $56 million from FY05. The budget cut will delay selection of the second New Frontiers mission. The first mission, called New Horizons, a mission to Pluto, is scheduled to be launched next year.

Aeronautics Research

The budget request for Aeronautics is $852 million, a decrease of $54 million from FY05 and $182 million below the FY04 level of $1.034 billion. The Aeronautics program has three main components, Aviation Safety and Security, Airspace Systems, and Vehicle systems. NASA proposes to limit research within Vehicle Systems to activities related to noise and emissions reductions, and unmanned aerial vehicles. Vehicle Systems is a big user of wind tunnels, and maintaining these facilities puts significant pressure on the budget. NASA is proposing to restructure its research programs to focus on those that do not depend as heavily on wind tunnel tests.

Education Programs

NASA proposes $167 million for its education programs, $2 million less than FY05, or a one percent cut. NASA's FY06 budget run-out projects that education will get cut again in FY07, bringing it down to $155 million where it will remain at that level through 2010.

Other Issues:

Financial Management Issues at NASA

In three of the past four years, NASA has not been able to produce auditable financial statements; its financial auditors disclaimed opinions on NASA's financial statements for fiscal years 2001, 2003, and 2004. NASA's new auditors for FY 2004, Ernst & Young, reported that many financial management weaknesses continue to persist, including the following:

- NASA has not been able to reconcile its Fund Balance with Treasury account since FY 2003. Although NASA reportedly has resolved many of the errors causing a difference of almost $2 billion as of September 30, 2003, Ernst & Young identified unreconciled differences between NASA and Treasury of $313 million as of September 30, 2004.
- NASA lacks adequate controls to ensure that its Property, Plant, and Equipment and Materials and Supplies are properly valued and accounted for. As of the end of FY 2004, NASA reported the value of these assets as $37.6 billion.
- NASA lacks an integrated financial management system, as required by the *Federal Financial Management Improvement Act of 1996.*

In April 2000, NASA began development of its Integrated Financial Management Program (IFMP), consisting of nine systems or modules to support a range of activities, including accounting, asset management, contract administration, and human resource management. The Core Financial module, considered the backbone of IFMP, was implemented in 2003. However, the Government Accountability Office (GAO) reported that NASA did not follow disciplined processes in implementing this module and as a result, NASA has been experiencing numerous data integrity problems with the system. Ernst & Young recently reported that the Core Financial module is not integrated with certain subsidiary systems, does not facilitate the preparation of financial statements, and does not contain sufficient controls to detect and correct invalid data in a timely fashion. According to NASA, problems with the Core Financial module are the cause of $565 billion in adjustments needed to complete its FY 2004 financial statements.

NASA plans to complete implementation of all nine IFMP modules by FY07. While NASA has estimated the life cycle cost of IFMP to be almost $1 billion, GAO found that this estimate does not include all costs.

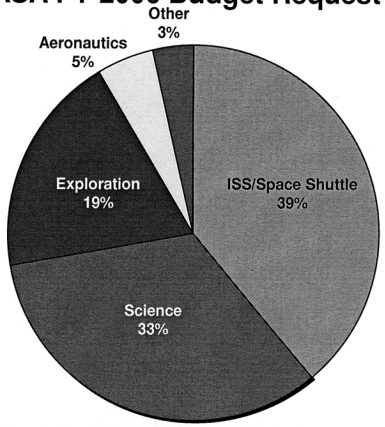
Workforce

To support the Vision, NASA has said that it needs to "transform" its workforce into a smaller force with a different set of skills than those possessed by its current employees. Overall, the agency aims to reduce its total workforce from 19,227 full-time employees in FY05 to 18,798 in FY06, a net reduction of 429 employees.

The total additions and reductions in staff are likely to be greater, however, as NASA has determined that about 2,000 of its employees have skills that are not well matched to the skills the agency now believes it needs. NASA believes that it simply no longer needs the skills of about 1,000 of these employees, many of them technicians that work in with aeronautics research facilities. NASA has offered voluntary buy-outs to these employees, but as of January 12, only 302 employees had accepted them. As of February 7, NASA has given its center directors approval to begin talking about the potential for positions to be eliminated and the news has been covered widely in media reports, so the number of employees taking voluntary buy-outs may increase.

NASA believes the other 1,000 employees might be able to compete for future projects and thus retain their jobs, but that outcome is uncertain and it is possible that the agency would eventually resort to mandatory Reductions In Force (RIFs) to accomplish its workforce goals.

NASA FY 2006 Budget Request



$ in millions	FY2005 12/23 Op Plan	FY 2006 budget request	FY2007 budget request	FY2008 budget request	FY2009 budget request	FY 2010 budget request
Science	5,527	5,476	5,960	6,503	6,853	6,798
Exploration Systems	2,685	3,165	3,707	3,826	4,474	5,126
Aeronautics	906	852	728	731	728	718
ISS/Space Shuttle	6,219	6,388	6,007	5,657	4,967	4,795
Other (Flight Support, Education, and IG)	733	575	560	590	590	592
Total	**16,070**	**16,456**	**16,962**	**17,305**	**17,612**	**18,027**
Emerg. Hurricane supp	126					

Chairman BOEHLERT. We have a crisis. Someone stole the Chairman's gavel. As a strong advocate of clean water, I will gavel this. This hearing will come to order.

I want to welcome everyone here this morning to this important hearing on the NASA budget. I see this hearing as the first in a series that will culminate in the introduction of a NASA authorization bill. Our goal is to get such a bill to the House Floor in time to influence the appropriations process. I know that is Chairman Calvert's goal as well, and I want to welcome him to his important responsibilities as Chairman of the Subcommittee. Last year, we were deeply engaged in that process behind the scenes. Now, we should be ready to go more public.

I want to do an authorization bill, because I think it is critical that Congress have a full and open debate on the President's *Vision for Space Exploration* and the future of NASA, before NASA barrels ahead with the program. Congress has never endorsed, in fact has never discussed the vision. What we did do, as part of a huge omnibus bill, is provide the money to enable NASA to continue planning how it wants to go forward, but the truly critical spending commitments start in fiscal year 2006, so this year is when we must have the debate.

Here are some of my current thoughts on how I would like that debate to come out. First, let me state clearly some things that I am for.

I am for returning humans to the Moon by 2020. I am for moving ahead prudently but swiftly with the development of a crew exploration vehicle for that purpose. I am for retiring the Space Shuttle as soon as possible, but under absolutely no circumstances later than December 31, 2010. That is, incidentally, compatible with the Administration's position. I am for a NASA that sees itself as a science agency with all of space science, Earth science, and aeronautics receiving the attention and funding according to priority areas. I am for a NASA that is open to outside ideas from academia and the private sector.

So where does that leave me on the current budget proposal? With the same mixed feelings I have had in the past. First, let me be blunt. I don't think NASA should be our top budget priority, either in this committee or in this Congress. That means in a budget as excruciating tight as this one, NASA probably should not get as much as the President has proposed. Moreover, even if NASA received every cent it has requested, it would still be trying to do too much at once, the historic pattern for the agency, as the Gehman Report noted. So something has to give, and this hearing will be a first step in looking at what that might be.

There is one other problem we have reviewing this budget. There are a lot of fundamental questions that NASA still isn't ready to answer. That is not a criticism of the agency. That is just a description of where they are in the planning process, and we have to keep that in mind.

What are some examples? They can't tell us what research will be done aboard the Station. They can't tell us how many more Shuttle flights will be scheduled. They can't tell us how they are going to get around the Iran Non-Proliferation Act. They can't tell us how many people the CEV will carry or whether it will go to

the Space Station. They can't tell us what we might do when we go to the Moon. And they obviously can't tell us whether the Shuttle will once again fly successfully.

Again, that is not because NASA hasn't been forthcoming. Quite the contrary. Top NASA officials have spent countless hours with us, giving direct and candid answers to a wide range of questions. But they can't provide answers that they don't yet have, and we need to understand just how much is unknown, the extent, for example, the cost—that cost estimates for the CEV and Project Prometheus are still "placeholders."

So one thing I will be asking today is when some of our questions might be answered.

I know some answers should be forthcoming soon. We understand, for example, that the Administration could send up in the next month or so proposed to language to amend the Iran Non-Proliferation Act. That is a critical matter, because the current law would bring the Station program to a halt by next April. Any proposal will be reviewed very carefully. The only thing I can say now, and I think the Administration agrees with this, is the Station is a lot less important than non-proliferation is. I am not interested in having go into space because we've blown ourselves up.

Well, with so many questions, let me just stop there. We have before us Fred Gregory, the Deputy Administrator of NASA, who has been an integral part of all the decision-making that went into the '06 proposal. The agency will be in good hands as he becomes Acting Administrator this weekend. But I am sure that he is as eager as anyone in this town to see an end to the parlor game or predicting who will be appointed when to succeed Sean O'Keefe. But I am as helpless as he is in bringing that about.

Sean O'Keefe left the agency far stronger than he found it. Now, we need to decide what the next step is in creating a strong and productive NASA.

Mr. Gordon.

[The prepared statement of Chairman Boehlert follows:]

PREPARED STATEMENT OF CHAIRMAN SHERWOOD L. BOEHLERT

I want to welcome everyone here this morning to this important hearing on the NASA budget. I see this hearing as the first in a series that will culminate in the introduction of a NASA authorization bill. Our goal is to get such a bill to the House Floor in time to influence the appropriations process. I know that is Chairman Calvert's goal as well. Last year, we were deeply engaged in that process behind the scenes; now we should be ready for a public role.

I want to do an authorization bill because I think it's critical that Congress have a full and open debate on the President's *Vision for Space Exploration* and the future of NASA before NASA barrels ahead with the program. Congress has never endorsed—in fact, has never discussed—the Vision. What we did do, as part of a huge Omnibus bill, is provide the money to enable NASA to continue planning how it wants to go forward. But the truly critical spending commitments start in FY06, so this year is when we must have the debate.

Here are some of my current thoughts about how I'd like that debate to come out. First, let me state clearly some things that I am for.

I am for returning humans to the Moon by 2020. I am for moving ahead prudently but swiftly with the development of a Crew Exploration Vehicle (CEV) for that purpose. I am for retiring the Space Shuttle as soon as possible, but under absolutely no circumstances later than December 31, 2010. I am for a NASA that sees itself as a science agency, with all of Space Science, Earth Science and Aeronautics receiving the attention and funding accorded to priority areas. I am for a NASA that is open to outside ideas from academia and the private sector.

So where does that leave me on the current budget proposal? With the same mixed feelings I've had in the past. First, let me blunt, I don't think NASA should be our top budget priority either in this committee or the Congress. That means in a budget as excruciatingly tight as this one, NASA probably should not get as much as the President has proposed. Moreover, even if NASA received every cent it has requested, it would still be trying to do too much at once—the historic pattern for the Agency, as the Gehman Report noted. So something has to give, and this hearing will be a first step in looking at what that might be.

There's one other problem we have reviewing this budget. There are a lot of fundamental questions that NASA still isn't ready to answer. That's not a criticism of the Agency. That's just a description of where they are in the planning process, and we have to keep it in mind.

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Again, this is not because NASA hasn't been forthcoming. Quite the contrary. Top NASA officials have spent countless hours with our staff, giving direct and candid answers to a wide range of questions. But they can't provide answers that they don't yet have. And we need to understand just how much is unknown—the extent, for example, that cost estimates for the CEV and Project Prometheus are still (quote) "placeholders."

So, one thing I'll be asking today is when some of our questions might be answered.

I know some answers should be forthcoming soon. We understand, for example, that the Administration could send up in the next month or so proposed language to amend the Iran Nonproliferation Act. That's a critical matter because the current law would bring the Station program to a halt by next April. Any proposal will be reviewed carefully. The only thing I can say now—and I think the Administration agrees with this—is that the Station is a lot less important than non-proliferation is. I'm not interested in having go into space because we've blown ourselves up.

Well, with so many questions pending, let me stop there. We have before us Fred Gregory, the deputy administrator of NASA, who has been an integral part of all the decision-making that went into the FY06 proposal. The Agency will be in good hands as he becomes acting Administrator this weekend. But I am sure that he is as eager as anyone in this town to see and end to the parlor game of predicting who will be appointed when to succeed Sean O'Keefe. But I'm as helpless as he is in bringing that about.

Sean left the Agency far stronger than he found it. Now we need to decide what the next steps in creating a strong and productive NASA should be.

Mr. Gordon.

Mr. GORDON. Thank you, Mr. Chairman. I would like to join you in welcoming Mr. Gregory to today's hearing, and I want to sincerely thank him for his long service to our country and to NASA, and to say I am very pleased that you are going to top this off by not just being interim, but the Acting Director for NASA. I think it is a position well deserved.

You know, I feel a little embarrassed that I continually agree with the Chairman. The Committee—the Ranking Member is supposed to be raising some Cain here, but I think that our Chairman very well has stated what I think is the right view of our position, and looking at NASA now, I am very pleased that we are going to go forward with additional hearings, and have an authorization. I would have to say I disagree on the importance of NASA's budget. I would like to see that number not only stay where it is, but be increased. But again, I want to concur with the very good statement of our Chairman.

I would also like to take a moment to acknowledge and welcome all of the new members of the Committee on both sides of the aisle, as well as to extend my good wishes to Representative Calvert and

Representative Udall, as they embark on their responsibilities as chair and Ranking Member of the Space and Aeronautics Subcommittee. In those capacities, they will be leading the NASA-related issues on a regular basis, and I have no doubt they will do a good job.

Mr. Chairman, today's hearing is likely to be one of the most important that we hold this session. More than a year ago has now—or more than a year has now passed since President Bush announced his Space Exploration Initiative. I for one support the President's proposal, but it needs to be paid for and sustainable. However, since the time the initiative was first announced, there has been little opportunity for Congressional scrutiny, and there has been no opportunity to develop a consensus on what Congress or the American people thinks of this initiative, which is very important if this Committee is to successfully convince our colleagues to continue its funding for several years during tight budgets.

And while some have argued that the funding provided to NASA in Fiscal year 2005 omnibus appropriations constituted a Congressional mandate for the President's initiative, others would disagree. In point of fact, Congress was being asked to vote up or down on a $388 billion spending bill, funding a wide array of agencies and activities, with no opportunity for amendments. NASA's funding accounted for only four percent of the total funding of that bill, and despite the fact that NASA received close to its fiscal year 2005 request level, $1.5 billion of funds provided to NASA in the omnibus are going to be needed to pay for things like the increase in the Shuttle return-to-flight costs that weren't in the original fiscal year 2005 request.

So it appears that we are entering this year with Congress' position on the Exploration Initiative still unresolved. It also appears that Congress is going to have to address some fundamental issues as we assist the President—assess the President's proposal, notably, what priority should the President's Exploration Initiative have, relative to NASA's other important missions? Are we prepared to maintain the funding and the schedule of the President's initiative, even if it results in the loss of opportunities in space and Earth science, and aeronautics research, and microgravity research and applications, in research into low-cost and high reliability launch capacities and technologies, or in other significant research areas?

What role do we want NASA centers to play in the future? What type of workforce do we envision for NASA? In that regard, are we prepared to shed highly skilled scientists, engineers, and technicians from NASA's workforce if they do not directly support the requirements of the President's initiative? These are not idle questions. They go to the heart of what we want from our nation's civil space and aeronautics program. Moreover, I do not believe that Congress has the luxury of deferring considerations of these questions any longer. One thing is clear from NASA's fiscal year 2006 budget request and from recent actions taken by the agency. In the absence of any clear Congressional direction, NASA is proceeding to move out aggressively to implement the President's initiative. As a result, we are starting to get a clear picture of the Administration's vision for NASA. For example, just one year after President

Bush launched his space initiative, the Administration has already started backpedaling on multi-year funding profile it had proposed for the agency. As a result, the Administration is planning to cut a total of some $2.5 billion from the budget plan for fiscal year 2006 through fiscal year 2009 that had been proposed for NASA just a year ago.

It is also instructive to see how NASA proposes to allocate the cut. It allocates 75 percent of the required cuts to NASA's science and aeronautics program, with just 10 percent having to be absorbed by NASA's exploration systems programs. What other clues do NASA's new priorities—are displayed in this year's budget request? As we have all heard, NASA is eliminating the funding for servicing the highly productive Hubble Space Telescope. NASA is cutting funding it contributes to the National Interagency Initiatives in nanotechnology, networking, information technology, and climate change science. NASA is eliminating funding for hypersonics research. NASA is reducing Space Shuttle Operation reserves in fiscal year 2006 and 2007, in order to support the funding requirements of the Exploration Initiative. NASA is cutting the funding for its science mission operations account, an action that will force the termination of some ongoing scientific spacecraft missions within the next year. I could cite other examples, but you get the picture.

Contrary to the image it has fostered of a measured, go as you pay approach for exploration, the fact is that NASA is protecting the funding for its Exploration Initiative at the expense of other programs. I think it is reasonable to assume that unless directed otherwise, NASA will continue that approach in the future, as deficit concerns increasingly squeeze the agency's budgetary bottom line. And as I have previously stated, I am a strong supporter of exploration. I think it is important for our nation's human space flight program to be—to have a challenging, long-term goal. And I agree with the President that a step by step plan for exploration makes the best sense. At the same time, I am very concerned that the approach NASA is taking to exploration is not going to be sustainable.

I am speaking as one who has to convince other Members of Congress of the value of investing in NASA at a time when a host of other national priorities are competing for the same dollars. It doesn't make my job any easier when Members see NASA cutting its commitment to aeronautics research that could reduce aircraft noise and emissions, and—or improve efficiency and safety of the air traffic management system, or cutting its commitment to research that could help us better understand the impact of the sun on weather and climate. Or eliminating research for the International Space Station that NASA has long asserted would benefit the health and welfare of our citizens back here on Earth, especially if they suspect that NASA is making those cuts in order to shift money to an Exploration Initiative whose budget doesn't match its goals.

It becomes even more difficult when these same Members look at what NASA has been doing as part of its exploration initiative, and start asking questions such as how could NASA first make the Jupiter Icy Moons Orbiter mission its showcase flight demonstration

of the initiative's nuclear technology program, and then wind up having to shelve it because of, and I quote "concerns over cost and technical complexity." Well, why did NASA make purchasing Russia's Soyuz crew transfer and rescue services a basic elements of its human space flight plan when the current law prohibits such purchases? And now that NASA has done it, what is it going to do next to make it work? Or finally, how does NASA justify its apparent willingness to spend U.S. tax dollars to support European aerospace companies as part of the Crew Exploration Vehicle program? I don't have good answers to these questions, and I hope that Mr. Gregory will address them at today's hearing.

Now, before I close, I would like to raise one final issue. NASA is starting to make sweeping changes in its workforce and centers, with the potential for several thousands of its employees to be let go, numerous facilities to be consolidated or done away with, and one or more of the centers to be privatized or even closed. Yet neither Congress nor NASA's own employees are being given a clear picture of what is planned. I don't think it is right to treat the dedicated men and women of NASA's workforce that way, and I don't think it is the appropriate way to deal with Congress.

Mr. Chairman, we have important issues in front of us that need our attention. We can start to address them at today's hearing, but I hope that we will not stop with a single hearing. We need to devote whatever time and oversight effort is needed to chart a reasonable path for NASA, and it needs to be a path that is sustainable. I don't want to see us on the Floor of the House in a couple of years losing a vote to continue the program. I can still remember when the Space Station program avoided a similar fate by only one vote in 1993.

With that, I again want to welcome Mr. Gregory to today's hearing, and I look forward to your testimony.

[The prepared statement of Mr. Gordon follows:]

PREPARED STATEMENT OF REPRESENTATIVE BART GORDON

Good morning. I'd like to join the Chairman in welcoming Mr. Gregory to today's hearing.

I'd also like to take a moment to acknowledge and welcome all of the new Members of the Committee on both sides of the aisle, as well as extend my good wishes to Rep. Calvert and Rep. Udall as they embark on their responsibilities as Chair and Ranking Member of the Space and Aeronautics Subcommittee. In those capacities they will be dealing with NASA-related issues on a regular basis, and I have no doubt that they will do a good job.

Mr. Chairman, today's hearing is likely to be one of the most important ones we hold this Session. More than a year has now passed since President Bush announced his space exploration initiative.

I for one support the President's proposal if it is paid for and is sustainable. However, since the time the initiative was first announced, there has been little opportunity for Congressional scrutiny or debate of the proposal. And there has been no opportunity to develop a consensus on what Congress thinks of the initiative, which is very important if this committee is to successfully convince our colleagues to continue its funding for several years during tight budgets.

While some have argued that the funding provided to NASA in the Fiscal Year 2005 omnibus appropriation constituted a Congressional "mandate" for the President's initiative, others would disagree. In point of fact, Congress was being asked to vote up or down on a $388 billion spending bill funding a wide range of agencies and activities—with no opportunity for amendments. NASA's funding accounted for only about four percent of the total funding in that bill. And despite the fact that NASA received close to its FY05 request level, $1.5 billion of the funds provided to

NASA in the Omnibus are going to be needed to pay for things—like the increase in Shuttle return-to-flight costs—that weren't in the original FY05 request.

So, it appears that we are entering this year with Congress's position on the exploration initiative still unresolved. It also appears that Congress is going to have to address some fundamental issues as we assess the President's proposal, notably:

- What priority should the President's exploration initiative have relative to NASA's other important missions?
- Are we prepared to maintain the funding and schedule of the President's initiative even if it results in the loss of opportunities in space and Earth science, in aeronautics research, in microgravity research and applications, in research into low cost/high reliability launch technologies, or in other significant research areas?
- What role do we want NASA's Centers to play in the future?
- What type of workforce do we envision for NASA?
- In that regard, are we prepared to shed highly skilled scientists, engineers, and technicians from NASA's workforce if they do not directly support the requirements of the President's initiative?

These are not idle questions—they go to the heart of what we want from our nation's civil space and aeronautics program. Moreover, I do not believe that Congress has the luxury of deferring consideration of these questions any longer.

One thing is clear from NASA's FY06 budget request and from recent actions taken by the agency: In the absence of any clear Congressional direction, NASA is proceeding to move out aggressively to implement the President's initiative.

As a result, we are starting to get a clearer picture of the Administration's vision for NASA. For example, just one year after President Bush launched his space exploration initiative, the Administration has already started back-pedaling on the multi-year funding profile it had proposed for the agency.

As a result, the Administration is planning to cut a total of some $2.5 billion from the budget plan for FY06 through FY09 that it had proposed for NASA just a year ago.

It is instructive to see how NASA proposes to allocate that cut—it would allocate 75 percent of the required cuts to NASA's science and aeronautics programs with just 10 percent having to be absorbed by NASA's Exploration Systems programs.

What other clues to NASA's new priorities are displayed in this year's budget request?

- As we have all heard, NASA is eliminating the funding for servicing the highly productive Hubble Space Telescope.
- NASA is cutting the funding it contributes to the national interagency initiatives in Nanotechnology, Networking and Information Technology, and Climate Change Science.
- NASA is eliminating funding for hypersonics research.
- NASA is reducing Space Shuttle operations reserves in FY06 and FY07 in order to support the funding requirements of the exploration initiative.
- NASA is cutting the funding for its science mission operations account-an action that will force the termination of some ongoing scientific spacecraft missions within the next year.

I could cite other examples, but you get the picture.

Contrary to the image it has fostered of a measured, "go as you pay" approach to exploration, the fact is that NASA is protecting the funding for its exploration initiative at the expense of its other programs.

I think it's reasonable to assume that unless directed otherwise, NASA will continue that approach in the future as deficit concerns increasingly squeeze the agency's budgetary bottom line.

As I have previously stated, I am a strong supporter of exploration. I think it's important for the Nation's human space flight program to have challenging long-term goals. And I agree with the President that a step-by-step plan for exploration makes the best sense.

At the same time, I'm very concerned that the approach NASA is taking to exploration is not going to be sustainable. I'm speaking as one who has to convince other Members of Congress of the value of investing in NASA at a time when a host of other national priorities are competing for those same dollars.

It doesn't make my job any easier when Members see NASA cutting its commitment to aeronautics research that could reduce aircraft noise and emissions or improve the efficiency and safety of the air traffic management system, or cutting its

commitment to research that could help us better understand the impact of the Sun on our weather and climate, or eliminating research on the International Space Station that NASA has long asserted would benefit the health and welfare of our citizens back here on Earth—especially if they suspect that NASA is making those cuts in order to shift money to an exploration initiative whose budget doesn't match its goals.

It becomes even more difficult when those same Members look at what NASA's been doing as part of its exploration initiative and start asking questions:

- Such as, how could NASA first make the Jupiter Icy Moons Orbiter (JIMO) mission its showcase flight demonstration of the initiative's nuclear technology program and then wind up having to shelve it because of "concerns over costs and technical complexity. . ."?
- Or, why did NASA make purchasing Russian Soyuz crew transfer and rescue services a basic element of its human space flight plan when current law prohibits such purchases? And now that NASA's done it, what's it going to do next to make it work?
- Or finally, how does NASA justify its apparent willingness to spend U.S. taxpayer dollars to support European aerospace companies as part of the Crew Exploration Vehicle (CEV) program?

I don't have good answers to those questions, and I hope that Mr. Gregory will address them at today's hearing.

Now before I close, I would like to raise one additional issue. NASA is starting to make sweeping changes to its workforce and Centers, with the potential for several thousand of its employees to be let go, numerous facilities to be consolidated or done away with, and one or more of its Centers to be privatized or even closed.

Yet neither Congress nor NASA's own employees are being given a clear picture of what is planned. I don't think that's the right way to treat the dedicated men and women of NASA's workforce. And I don't think it is an appropriate way to deal with Congress.

Mr. Chairman, we have important issues in front of us that need our attention. We can start to address them at today's hearing, but I hope that we will not stop with a single hearing. We need to devote whatever time and oversight effort is needed to chart a responsible path forward for NASA. And it needs to be a path that is sustainable.

I don't want to see us on the Floor of the House in a couple of years losing a vote to continue the program—I can still remember when the Space Station program avoided a similar fate by only one vote in 1993.

With that, I again want to welcome Mr. Gregory to today's hearing. I look forward to your testimony.

Chairman BOEHLERT. Thank you very much, Mr. Gordon. The Chairman of the Subcommittee on Space and Aeronautics, Mr. Calvert.

Mr. CALVERT. Thank you, Mr. Chairman, and I—also looking forward to working with Mr. Udall, as I take on this—a new responsibility, and I would like to welcome Mr. Gregory for his—and his colleagues today to this important hearing, a hearing that will set the stage for the rest of the year. There are a lot of issues that we are going to cover today, so I will keep my remarks very brief.

As we all know, this is a crucial time for NASA and the civil space program. NASA has made progress toward returning the Shuttle to flight, but some technical issues remain. We hope and believe the Shuttle will return to flight when it is ready and continue the assembly of the International Space Station. But as you said, no later than 2010, the Shuttle will be retired, so we can move forward with the exciting and bold exploration vision laid out by the President over a year ago, a vision that I strongly support.

Today, it is important that we get a better understanding of the priorities reflected in NASA's budget proposal and specifics of how NASA intends to implement this vision. We also want to know how NASA intends to refocus its programs on the exploration vision

while rebalancing its portfolio of science, aeronautics programs, since these programs are also important to the Nation.

To help illuminate this issue, I plan to hold hearings focusing specifically on NASA's various roles, missions, and infrastructure. Just as important, I want to ensure that we get to work early to pass an authorization bill for NASA. We haven't passed one since 2000. I think it is important we not turn our responsibilities over to the appropriators as we enter a new era of space exploration.

Lastly, I also look forward to the hearing on how NASA plans to expand, accelerate, and accommodate America's growing commercial and entrepreneurial spacefaring community. NASA has a lot on its plate. As this new Subcommittee Chairman, I look forward to working with all my colleagues on this committee, the Administration, and NASA to make sure the space program a success, and with that, I thank you, Mr. Chairman. I look forward to the hearing.

[The prepared statement of Mr. Calvert follows:]

PREPARED STATEMENT OF REPRESENTATIVE KEN CALVERT

Mr. Chairman, thank you. I would like to welcome Mr. Gregory and his colleagues today to this important hearing, a hearing that will set the stage for the rest of the year. There are a lot of issues we need to cover, so I will keep my remarks very brief. As we all know, this is a critical time for NASA and the civil space program. NASA has made solid progress toward returning the Shuttle to flight, but some tough technical issues remain. We hope and believe that the Shuttle will return to flight when it is ready and continue the assembly of the International Space Station. In 2010, the Shuttle will be retired, so we can move forward with the exciting and bold exploration vision laid out by the President over a year ago.

Today, it is important that we get a better understanding of the priorities reflected in NASA's budget proposal and the specifics of how NASA intends to implement the vision. We also want to know how NASA intends to refocus its programs on the exploration vision while maintaining a balanced portfolio of science and aeronautics programs, since these programs are also vitally important to the Nation.

NASA has a lot on its plate and as the new Subcommittee Chairman I look forward to working with my colleagues on the Committee, the Administration, and NASA to make sure our space program is a success.

Thank you, Mr. Chairman.

Chairman BOEHLERT. Thank you very much, Mr. Chairman. Now, Mr. Udall, the Ranking Member of the Subcommittee on Space and Aeronautics.

Mr. UDALL. Thank you, Mr. Chairman, and welcome, Mr. Gregory. We look forward to hearing your testimony today.

As we all know, NASA is an important part of the Nation's science and technology infrastructure, and at their best, NASA's activities advance knowledge, inspire our youth, and improve the quality of life for our citizens. So it is important that Congress be involved in decisions on NASA's future, and along with my colleagues, I think this, and I know this hearing can be a good start toward gaining the information that we will need to make sure that those decisions are informed ones. In that regard, I look forward to working with Mr. Calvert in my new capacity as Ranking Member on the Space and Aeronautics Subcommittee to carry out additional oversight.

Mr. Chairman, as you do, I consider myself to be a champion of space exploration in its broadest sense, which is the adventure of pushing back the boundaries of our ignorance with both robotic and human explorers, as well as with researchers in the laboratory and

the observatory. I confess that I am—as I think we all are here, a bit troubled that the President's Exploration Initiative seems to be couched in terms of having to walk away from important research areas in science and aeronautics if we want to do exploration. One of those important research projects is, of course, the Hubble Telescope, which we all intend to discuss further during this hearing. But it is not the only one. Nevertheless, I think we are being presented with a false choice. We should be able to do both. It may require adjusting the pace of the President's Exploration Initiative, or making a tough love prioritization of the proposed exploration programs, but I believe it can be done. To do otherwise is to risk losing the fruits of investments we have made over the last 45 years to establish and maintain our current world class capabilities for research at NASA and at our universities.

In addition, I think we should never forget that an important component of those world class capabilities is in the NASA workforce. As you may know, I have several federal laboratories in my district, and I have developed a keen appreciation for the intellectual capital that resides in those laboratories. And I have no doubt that similarly impressive intellectual capital exists at the NASA centers, though in contemplating changes to NASA's workforce, we should proceed very carefully. Change by itself is inherently neither good nor bad. It is just change. However, if we make precipitous changes to those centers without considering what the Nation will want from NASA in the future, we risk losing valuable skills and intellectual capital that we may never be able to recover.

Now, I know that some champions of the President's vision want to move quickly to realign NASA to conform to that vision. However, as Members of Congress, I think we need to step back and take the broader view. We need to ask some hard questions, such as what do we want NASA to be? What are we asking NASA to contribute to our society and to our economy, and what steps do we need to make to ensure that NASA will retain the capacity to make those contributions for decades to come? It is not going to be easy to answer these questions. Nevertheless, it is vital that Congress, working with the Administration, try to answer them.

With that, Mr. Chairman, I yield back the balance of my time, and I welcome you again, Mr. Gregory, and look forward to your testimony. Thank you.

[The prepared statement of Mr. Udall follows:]

PREPARED STATEMENT OF REPRESENTATIVE MARK UDALL

Good morning, and welcome Mr. Gregory—we look forward to hearing your testimony. As we all know, NASA is an important part of the Nation's science and technology infrastructure. At their best, NASA's activities advance knowledge, inspire our youth, and improve the quality of life for our citizens. So it's important that Congress be involved in decisions on NASA's future, and I think this hearing can be a good start toward gaining the information we will need to make sure that those decisions are *informed* ones. In that regard, I look forward to working with Mr. Calvert in my new capacity as Ranking Member on the Space and Aeronautics Subcommittee to carry out additional oversight.

Mr. Chairman, I consider myself to be a champion of space exploration in its broadest sense—the adventure of pushing back the boundaries of our ignorance with both robotic and human explorers, as well as with researchers in the laboratory and the observatory. I confess that I am a bit troubled that the President's exploration initiative seems to be couched in terms of having to walk away from important research areas in science and aeronautics if we want to do exploration. One of those

important research projects is of course the Hubble Telescope, which I intend to discuss further during this hearing, but it's not the only one.

Nevertheless, I think we're being presented with a false choice. We should be able to do both. It may require adjusting the pace of the President's exploration initiative, or making a "tough love" prioritization of the proposed exploration programs. . .but I believe it can be done. To do otherwise is to risk losing the fruits of investments we have made over the last 45 years or more to establish and maintain our current world-class capabilities for research at NASA and at our universities across a wide range of scientific and technological disciplines.

In addition, I think we should never forget that an important component of those world-class capabilities is the NASA workforce. As you may know, I have several federal laboratories in my district. I have developed a keen appreciation for the intellectual capital that resides in those laboratories. And I have no doubt that similarly impressive intellectual capital exists at the NASA Centers. When contemplating changes to NASA's workforce, we should proceed very carefully. Change by itself is inherently neither good nor bad—it's just change. However, if we make precipitous changes to those Centers without considering what the Nation will want from NASA in the future.. . . We risk losing valuable skills and intellectual capital that we may never be able to recover.

I know that some champions of the President's exploration vision want to move quickly to realign NASA to conform to that vision. However, as Members of Congress, I think we need to step back and take the broader view. We need to ask some hard questions.. . . What do we want NASA to be? What are we asking NASA to contribute to our society? To our economy? And what steps do we need to take to ensure that NASA will retain the capacity to make those contributions for decades to come? It's not going to be easy to answer these questions. Nevertheless, it's vital that Congress, working with the Administration, try to answer them.

With that, Mr. Chairman, I yield back the balance of my time. Thank you.

Chairman BOEHLERT. Thank you very much, Mr. Udall.

[The prepared statement of Mr. Ehlers follows:]

PREPARED STATEMENT OF REPRESENTATIVE VERNON J. EHLERS

I believe that NASA's decision to abandon a Hubble telescope servicing mission is unwise and shortsighted. Given Hubble's tremendous history of scientific discovery and its continuing potential, there is no question as to the value of such a mission. I understand that the reasoning that led to this decision for decommissioning instead of a servicing mission is the purported safety risks to astronauts. While this is, of course, an important consideration, I believe the calculated risk does not outweigh the potential benefits of such a mission.

Currently, there are 28 different missions planned by the Space Shuttle to the International Space Station (ISS) before the vessel's retirement in 2010. With a history of only two accidents in 113 Shuttle flights, for any single flight there is a 1.8 percent chance of failure. With 28 planned missions to the ISS, the cumulative risk of a single accident over the course of those missions is substantially higher (almost 40 percent). Simple mathematics shows me that one mission to service the Hubble telescope makes sense, given the minimal risk to the astronauts and the tremendous and proven scientific potential of the instrument. Coupled with the time that will be lost before another telescope is launched, decommissioning this telescope is clearly a questionable decision. In the case of Hubble, stewardship of our existing telescope is the smartest investment of our federal dollars.

With a 1.8 percent risk to the astronauts of one Hubble mission, we get a tremendous amount of science accomplished, whereas, with the 28 missions to the ISS there is uncertain scientific achievement coupled with a significantly higher risk. If NASA's goal is to conduct missions of the greatest scientific value and least amount of risk to astronauts, then clearly, a single mission to fix Hubble is the right decision.

[The prepared statement of Mr. Forbes follows:]

PREPARED STATEMENT OF REPRESENTATIVE J. RANDY FORBES

In only the last half century, space exploration and scientific discovery have brought an unquantifiable richness to human life. America's space program is a symbol of our success as a scientifically and technologically advanced nation. I am pleased that President Bush has devised a plan that seeks to advance human space

exploration, however I am concerned that the FY 2006 Budget proposes cuts to vital programs that are not related to NASA's *Vision for Space Exploration.*

In particular, I remain concerned that reduced federal funding for aviation and aeronautics research and technology in FY 2006 will jeopardize the Nation's leadership in providing the technologies needed to develop the next generation aircraft, improve aviation safety and security, and attract the next generation of aerospace scientists and engineers. We are in danger of falling behind our competitors in Europe who have announced that their goal is to dominate commercial aviation sales by 2020.

In addition, cuts to the NASA Aeronautics budget will have a profound impact on the NASA Langley Research Center in Hampton, Virginia, which has a long and proud history of aeronautics research. NASA Langley's wind tunnels and laboratories, research aircraft and spacecraft and flight simulators have made significant contributions to our nation's advances in the aeronautics industry and have the promise of yielding many more in the future.

Like the explorers of the past and the pioneers of flight in the last century, we cannot identify today all that we will gain from aviation and aeronautics research; however, we know from experience that the eventual return will be great. And the greater the investments of today, the greater the rewards for generations to come.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Good morning. I want to thank Honorable Frederick Gregory for appearing before our committee to discuss the NASA's FY06 budget proposal. Today's hearing serves as an opportunity for oversight of certain departmental programs. On January 14, 2004, the President announced his space exploration initiative which provides much needed long-term goals for our nation's human space flight program. The lack of clear direction has hampered NASA's effectiveness and has kept it from realizing its full potential as the Nation's space agency. During last fall's FY05 Omnibus, the appropriators gave NASA a great deal of latitude to determine how their money would be allocated. The understanding was that the appropriations committees would review the funding programs as part of the Operating Plan process. Months later, it is unacceptable that NASA has only submitted an initial Operating Plan that provides only partial information on how it intends to allocate its FY05 appropriation. I support the action of Ranking Member Gordon, who sent a letter to NASA indicating that he did not concur with the Operating Plan submission because it was incomplete.

It is troubling that NASA continues to proceed on implementation of the President's exploration initiative in the absence of any clear Congressional direction on their priorities, their missions, and the future role of NASA Centers. In light of the President's new initiative, the budget for NASA leaves many significant questions unanswered and Congress needs more specifics as we consider the FY06 budget request for NASA.

NASA continues to be our gateway to the universe. It is through NASA's efforts that we will understand our planet, our solar system and beyond. NASA's budget should reflect a strong commitment to, and emphasis on, continuing to build the agency's core foundation of aeronautics and aerospace research and development as well as its missions of exploration and discovery to educate and inspire.

While the President's initiative envisions human lunar landings by 2020 and human missions to Mars at some point in the future, I am concerned that one year later, the budget plan for NASA has worsened, and the majority of the funding shortfall is to be absorbed by NASA's non-exploration initiative-related programs.

Finally, I am concerned that many important and promising programs, such as the education programs and space station research, would be eliminated or have their funding cut, deferred, or flattened in order to fund the space exploration initiative. NASA's track record on the credibility of its cost estimates over the last several years is at best mixed. The President's proposal will have a high price tag and it should not come at the cost of our commitment to our children, our veterans, our seniors, and our other important domestic priorities. The federal deficit for 2004 will be a record $413 billion and the case is going to have to be made to this committee and the American people why the space exploration initiative should be supported in the face of that deficit.

I welcome our witnesses and look forward to their testimony.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

First of all, I would like to thank the Chairman for bringing us together for this hearing today.

The purpose of this hearing is to examine the President's proposed budget for the National Aeronautics and Space Administration (NASA) for fiscal year 2006.

I have always been a strong supporter of the U.S. Space Program. I am a firm believer that the United States should continue our space program that has accomplished so much in the areas of research and science.

While I am happy that the Administration's budget request is an increase from last year's, there are still many questions that must be addressed. I am quite concerned that this budget is actually lower that what was stated for the President's *Vision for Space Exploration.* How does NASA plan on reaching these goals with $2.5 million less than what was original stated?

It is imperative that we today discuss safety and our return-to-flight plans, since space travel is inherently dangerous. Under no circumstances should we allow budget cuts to ever interfere with the responsibility of maintaining safety.

With that being said, I would like to again thank the Chair and Ranking Member for holding this hearing and the witness for agreeing to answer questions.

[The prepared statement of Mr. Honda follows:]

PREPARED STATEMENT OF REPRESENTATIVE MICHAEL M. HONDA

Chairman Boehlert and Ranking Member Gordon, thank you for holding this important hearing today. This is an essential first step in the oversight process it is our committee's responsibility to perform. I emphasize that this is a first step, however—we must be sure to pay close attention to NASA represented here, both to celebrate successes and to make sure the agency is doing the job we expect it to do in the way we expect it to do that job.

The number one issue in my mind as we discuss this budget is the "Transformation" that NASA is executing in order to carry out the President's *Vision for Space Exploration.* I am very concerned about the lack of Congressional oversight of this transformation and the fact that NASA has not provided us with timely information about changes that are taking place.

I know that our side of the aisle had serious concerns when NASA sought to switch to the Full Cost Accounting system, and I think that our greatest fears have come true. Full Cost Accounting has been combined with broad discretionary authority granted to the agency in the Fiscal Year 2005 Omnibus Appropriations bill to create a situation in which the salaries of vast numbers of Civil Service R&D employees are being moved out of project accounts and into general operations, which has created an artificial crisis at the centers and is being used as a reason to undertake large scale workforce reductions. To date, NASA has not provided us with a detailed Operations Plan outlining how these changes are being made, and NASA has not provided requested documentation outlining those "excess competencies" broken down by Center, so that it would be possible to see what areas NASA management considered to be no longer important to pursue. We must be kept informed, but NASA is doing everything to prevent that—according to a Center director, a page from NASA's budget submission to Congress about Civil Service employment numbers at the Centers should be ignored because it does not make any sense. How is it that Congress is not being given accurate information?

A big question in all of this "transforming" is whether NASA will continue to honor the obligations it has already made. There are many research contracts and cooperative agreements between the agency and Centers and outside entities whose status remains uncertain. Without a detailed Operations Plan, we can not know what the future of these agreements is.

I have a large number of questions that I want answers to, a larger number than I should have, because up to this point NASA has not been doing a good job of communicating with the Congress. I hope that I can start to get some answers to these questions at today's hearing.

[The prepared statement of Mr. Davis follows:]

PREPARED STATEMENT OF REPRESENTATIVE LINCOLN DAVIS

Good morning. Thank you, Mr. Chairman and Ranking Member.

As a member of the Congressional Blue Dog Coalition, I am a fiscal conservative. As we consider the Administration's aggressive proposal for a manned space mission to the Moon, I think that we need to think about fiscal priorities.

The Administration has repeatedly asked for billions upon billions of dollars for the Iraq conflict. An exit strategy has not been developed.

Our health care system is broken. More than 45 million people are uninsured. In my own State, TennCare is in danger of collapse and will cause thousands more to become uninsured.

And we are discussing an aggressive Space program? Mr. Chairman, my constituents and I understand the benefits of science and technology research, and we see the benefits of space research. But our nation is leaving a multi-trillion dollar deficit to its grandchildren, and as a Blue Dog, I want to express my disagreement with the Administration's aggressive space exploration agenda.

Thank you, Mr. Speaker. I yield back the balance of my time.

[The prepared statement of Mr. Carnahan follows:]

PREPARED STATEMENT OF REPRESENTATIVE RUSS CARNAHAN

Mr. Chairman and Mr. Ranking Member, thank you for hosting this hearing, and Mr. Gregory, thank you for joining us today to discuss the NASA proposed budget request. I am very interested in hearing your testimony.

I, as many on this committee, will be paying particular attention to what NASA's budgetary decisions mean for the long-term direction of the agency. I hope that you can elaborate on whether or not you believe it is possible for NASA to accomplish the President's space exploration agenda while simultaneously maintaining strong programs in each of NASA's mission areas.

Furthermore, I want to state that I am concerned about a few specific elements of the budget. Specifically, I am troubled by both the decision to discontinue funding for hypersonic work in both my home State of Missouri and in Tennessee as well as the potential for halting development of the ISS centrifuge facility. Finally, I believe it is problematic that bidding on the Crew Exploration Vehicle may produce an outcome in which non-U.S. companies are paid with U.S. taxpayer dollars.

[The prepared statement of Ms. Jackson Lee follows:]

PREPARED STATEMENT OF REPRESENTATIVE SHEILA JACKSON LEE

Chairman Boehlert, Ranking Member Gordon,

I want to thank you for organizing this important hearing to discuss NASA's budget proposal for fiscal year 2006. I want to welcome Mr. Gregory, NASA's Deputy Administrator and thank him for coming before this committee this morning. NASA faces a watershed moment after having endured a tremendous tragedy in the *Columbia* disaster and now trying to map its future with a return to the Moon and manned exploration of Mars.

Unfortunately, while I wholeheartedly support the work of NASA, I am deeply concerned that the President's budget does not meet all the needs for future space exploration as we move forward in this new century. As I have stated before, this Administration has made many bad budgetary choices, which continue to push us further into a huge deficits and mounting debt during the last four years. In addition, the President has proposed a highly questionable plan for Social Security along with an uncertain military future in Iraq that in conjunction with proposed $1.6 trillion tax cuts will result in less funds being available for vital agencies such as NASA.

I have been supportive of President Bush's *Vision for Space Exploration* because I firmly believe that the invest we make today in science and exploration will pay large dividends in the future. Similarly, I do not want to put a cap on the frontiers of our discovery, NASA should aim high and continue to push our nation at the forefront of space exploration. However, I find it to be more supportive of the President's plan, when I have no real specifics as to what this plan will entail. Large missions of this sort require detailed planning and as a Members of Congress we deserve to know how exactly the President's plan proposes to accomplish its objectives so that we can set out the proper resources and provide the necessary oversight. In addition, the President stated that the fundamental goal of his directive for the Nation's space exploration program is ". . .to advance U.S. scientific, security, and economic interests through a robust space exploration program." I could not agree more with that statement; unfortunately, this President's own budget does not meet the demands of his ambitious agenda. One year after the Administration laid out a five-year funding plan for NASA that was intended to demonstrate the affordability and sustainability of the exploration initiative, the Administration has submitted a budget proposal for 2006 that would reduce that funding plan by $2.5 billion over

the next four years. For example, in 2006, the Administration is seeking $546 million less than it said would be needed for NASA in 2006 in the five-year funding plan that accompanied last year's request. In fact 75 percent of the $2.5 billion shortfall will fall to NASA's science and aeronautics programs. This kind of under funding for vital programs is unacceptable. Again, it is even more alarming because the President has not provided a detailed plan as to how he intends to accomplish his space exploration agenda; certainly draining money from the budget will not help that cause.

My greatest concern with this budget is that it may not allocate enough money for ensuring the safety of all NASA astronauts and crew. After the *Columbia* disaster, safety must be our highest priority and it is worrisome that there is not a noticeable increase in funding to address all safety concerns. Presently, NASA is working towards a resumption of Space Shuttle flights, with return-to-flight currently scheduled for mid-May. However, once NASA returns the Shuttle to flight status, it is then supposed to begin the task of figuring out how to retire the Space Shuttle fleet in 2010 while continuing to fly the Shuttle safely up to the very last flight. I am concerned that pressure to retire the Shuttle by a fixed date to free up resources for other activities, coupled with the need to fly up to 28 Shuttle flights to assemble the Space Station, could—if not handled properly—lead to the types of schedule and budgetary pressures that were cited by the *Columbia* Accident Investigation Board (CAIB) as contributing to the *Columbia* accident. I hope this concern is paramount at NASA as we move forward in the future.

While this NASA budget is supposed to move us forward toward exciting new discoveries, I was deeply disturbed to find that this budget if approved will mean the end of the Hubble Space Telescope. The Hubble Space Telescope has been one of the most productive and successful scientific facilities ever deployed. Hubble was originally intended to be operated with periodic manned servicing missions using the Space Shuttle. However, since the grounding of the Shuttle, NASA Administrator O'Keefe has canceled the final scheduled servicing mission to Hubble. Without this servicing mission, Hubble's support systems (gyroscopes for maintaining orientation, batteries to power heaters) will fail causing irreversible damage to the spacecraft. Three servicing options have been identified to deal with Hubble: 1) complete the scheduled manned servicing mission; 2) use a robotic spacecraft to service Hubble; and 3) incorporate ground based replacement parts intended for Hubble in a new telescope. At this time, none of those options have been exercised. Unfortunately, the only funds attached for Hubble in this budget will go towards de-orbiting the telescope. I believe there is a better way to keep Hubble in service where it has served our nation and in fact the world so well. Now is not the time to digress in terms of our discovery, Hubble served an essential function in our space exploration efforts. I hope that this Committee and Congress as a whole will work to save the Hubble telescope before we lose a valuable asset.

As Members of this committee know, I have always been a strong advocate for NASA. My criticism of the President's budget is intended only to strengthen our efforts to move forward as we always have in the area of space exploration and discovery. NASA poses an exciting opportunity to charter a new path that can lead to untold discoveries. As always I look forward to working with the good men and women of NASA as we push the boundaries of our world once again.

[The prepared statement of Mr. Matheson follows:]

PREPARED STATEMENT OF REPRESENTATIVE JIM MATHESON

Thank you, Mr. Chairman and Ranking Member Gordon. As a supporter of science, I am well aware that space exploration benefits Americans by encouraging innovation in defense, education, communications, scientific research, and commercial technology.

Today, I am concerned that the benefits of research are being curtailed by NASA's foolhardy decision to cancel a servicing missing to the Hubble Space Telescope.

Hubble is one of the crown jewels of America's space science enterprise. Some of the greatest scientific benefits from the Hubble Space Telescope have been the unexpected discoveries that have expanded our knowledge about our solar system. It has also proven to be a powerful scientific and educational tool. I find it hard to believe that NASA is so willing to abandon this incredible project.

Just a few weeks ago, this committee heard testimony from Dr. Louis Lanzerotti, Chair of the National Research Council panel, who asked to examine the issues surrounding the cancellation of Hubble's final servicing mission. His panel's report concluded that NASA should commit to a Shuttle-based Hubble serving mission, allowing the telescope to continue its highly productive scientific mission.

Space industry workers in my home State of Utah and in other parts of our nation have already dedicated years of service to the Shuttle. They stand ready to continue that effort, so that Hubble can be serviced safely and efficiently. Finally, both the general public and the scientific community are very opposed to the discontinuation of Hubble and to the reckless postponement of needed servicing missions.

I hope that NASA reviews and reconsiders its decision to cancel what would have been the fifth and final Hubble servicing mission. Thank you.

Chairman BOEHLERT. Our first and only witness today is the Deputy Administrator, soon to be Acting Administrator of NASA, the Honorable Fred Gregory. We are very familiar with your work, Mr. Gregory. We thank you for your years of very distinguished service to the Nation in a variety of capacities. And I understand you will be accompanied by, and that is why we have the six chairs, Mr. James Jennings, Associate Deputy Administrator, Institutions and Asset Management; Rear Admiral Craig Steidle, Associate Administrator, Exploration Systems Mission Directorate; Mr. William Readdy, Associate Administrator, Space Operations Mission Directorate; Mr. Alphonso Diaz, Associate Administrator, Science Mission Directorate; Dr. Victor Lebacqz, Associate Administrator, Aeronautics Research Mission Directorate; and Mr. Steve Isakowitz, Comptroller, Office of the Chief Financial Officer. And Mr. Readdy, I am sorry for mispronouncing your name.

Gentleman, take your seats, behind a multi-hatted Mr. Gregory. Mr. Gregory, you know the drill. And usually, we ask witnesses, because we have many panels and many distinguished witnesses, to summarize the statement. We are not going to waive that. We would ask you to summarize your statement, but we are not going to be so arbitrary as to only give you five minutes. But the shorter your statement, the more opportunity we have for a dialogue, which we have always found to be the most productive part of these hearings.

So the floor is yours.

STATEMENT OF HON. FREDERICK D. GREGORY, DEPUTY ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. GREGORY. Well, first of all, let me tell you what a privilege it is to sit before such an august body. And Mr. Boehlert, thank you very much for inviting Mr. O'Keefe to come, and then allowing me to be, I hope, a worthy substitute. Ranking Member Gordon and the Committee Members, thank you for this opportunity to discuss this—NASA's fiscal year 2006 budget request.

This October 1, on the day when the new fiscal year begins, NASA will be entering our 48th year of serving the public interest, inspiring—and inspiring the next generation of explorers. For 31 years, I have had the privilege to serve on the NASA team, first as a test pilot, then as an astronaut, and more recently now as part of Agency leadership. I have never been as proud of our work and as hopeful about the space program's future as I am today. The exciting science findings on our Mars and Saturn missions, the research we are conducting on the International Space Station, and the assistance NASA satellites provided to Tsunami relief efforts highlight NASA's relevance in advancing America's scientific and technological leadership, and in providing people with tangible benefits.

These accomplishments in NASA's steady progress towards safety, safely returning the Space Shuttle to flight, are the products of a team that has strived very diligently since the *Columbia* accident to operate all our missions safely and successfully. They also reflect Sean O'Keefe's outstanding leadership of the Agency these past three years, and I certainly thank you for acknowledging Sean's work. To be certain, NASA's successes also reflect a strong spirit of cooperation between the Administration and Congress. We appreciate your role in helping us to set program priorities, and in providing constructive oversight of NASA activities. We look forward to working with you to help advance the Nation's *Vision for Space Exploration.* Now well under way, the Vision promises to advance U.S. scientific, security, and economic interests through a robust program of human and robotic space exploration.

Significantly, this budget will fully support the vision activities underway here on Earth, in low-Earth orbit, and throughout the solar system. It will also enable significant progress in other research priorities, such as aeronautics and Earth science. The budget as is—is, as promised, affordable, representing a 2.4 percent increase in a very tight fiscal environment. Finally, this budget is focused, as a result of NASA's disciplined effort to set priorities and align our workforce, organizational structures, facilities, and partnerships, with the unifying goals that many in Congress have long called for. The budget will provide resources to support Shuttle's safe Return-to-Flight, the continued assembly and operations of the International Space Station, progress on the Crew Exploration Vehicle, and the development of several transformative technologies. The budget will enable a new series of lunar science missions, beginning in 2008, and the new Mars missions, targeted to begin in 2011. And yes, this budget continues NASA's commitment to conducting world class astronomy. It will help us maintain our current fleet of orbiting laboratories, the Chandra, which is an X-ray observatory, the Spitzer, an infrared space telescope, and the Hubble Space Telescope, and develop impressive new tools, such as the James Webb Telescope and the Kepler Planet-Finding Telescope.

Under this budget plan, we will strive to extend the scientific lifetime of Hubble through at least 2007 and possibly further, as well as support the analysis of past and current Hubble images. The budget also builds on NASA's long-standing effort to improve life here, and better understand our home planet. It emphasizes our aeronautics research to enhance aviation safety and security, increases the efficiency of air traffic management, and invests in barrier-breaking technologies. Also, we will continue to add to the constellation of Earth-observing satellites, and develop new space-based technologies, and link systems for Earth observation.

Finally, we will determine—we are determined to inspire and motivate the next generation of explorers, through a variety of innovative programs, such as the NASA Explorer Schools and the Scholarship for Service program. Significantly, the Scholarship for Service program is one of the many elements of NASA's strategy to help ensure that we sustain the Vision over the long haul. Under this strategy, we are also taking steps to reshape NASA's workforce so that our skillsets are properly aligned with our mission requirements. This obviously will cause some impact on the NASA work-

force, but positively, we know that the vast majority of our existing skillset is directly applicable to this Vision. We also know that we have a large number of people eligible for retirement. Through our tools like the *Workforce Flexibility Act of 2004,* NASA plans to strategically build up our talent base for the future. To advance the Vision, we will also pursue innovative partnerships with academia, aerospace firms, and entrepreneurial companies. And we will encourage NASA centers to compete for useful work on technologies that can spin in to exploration agenda, and spin out into the economy at large.

Indeed, all of NASA's strategic and transformational changes are oriented to making the Agency an even more vital contributor to the prosperity and well being of the 21st Century America. That is what this budget is all about, investing in the great cause of exploration and discovery, and the development of revolutionary technologies and capabilities for the future.

I thank you once again for the opportunity to appear before this committee this morning, and I look forward to your questions. Thank you, sir.

[The prepared statement of Mr. Gregory follows:]

PREPARED STATEMENT OF FREDERICK D. GREGORY

Mr. Chairman and Members of the Committee, thank you for this opportunity to appear today to discuss NASA's plans for the future as represented in the President's FY 2006 budget request for NASA. I will outline the major budget highlights and discuss NASA's transformation progress and strategic direction, and describe how exciting the Nation's future will be in exploration and discovery.

As Members are aware, on January 14, 2004, President George W. Bush announced the *Vision for Space Exploration.* The President's directive gave NASA a new and historic focus and clear objectives. The fundamental goal of this directive for the Nation's space exploration program is ". . .to advance U.S. scientific, security, and economic interests through a robust space exploration program." In issuing this directive, the President committed the Nation to a journey of exploring the solar system and beyond, returning humans to the Moon, and sending robots and ultimately humans to Mars and other destinations. He challenged us to establish new and innovative programs to enhance our understanding of the planets, to ask new questions, and to answer questions as old as humankind. NASA enthusiastically embraced this directive and immediately began a long-term transformation that will enable us to achieve this goal.

In June 2004, the President's Commission on Implementation of the United States Space Exploration Policy, led by E.C. "Pete" Aldridge, Jr. (the Aldridge Commission), reported its findings and recommendations to the President. The Aldridge Commission emphasized the crucial role that technological innovation, national and international partnerships, and organizational transformation must play if we are to implement the President's *Vision* for an affordable and sustainable space exploration program. NASA is committed to making the necessary transformation to ensure our success in achieving the *Vision.*

The President demonstrated his commitment to the *Vision* by making it a priority in his FY 2005 budget request, and Congress responded positively by providing funding for NASA at the level requested by the President. The President has reaffirmed his commitment to the *Vision* by also making it a priority in his FY 2006 budget request. The $16.46 billion requested for NASA is an increase of 2.4 percent over FY 2005 in a very challenging budget environment.

Exploration Vision is Well Underway

Over the past year, NASA has made great strides in implementing the *Vision:*

- *Returning to Flight*—We are making final preparations for Shuttle return-to-flight as early as May 2005 and Space Station is entering its fifth year of continuous presence on-orbit.
- *Exploring Our Solar System and the Universe*—The Mars twin rovers are exceeding all expectations and making unprecedented discoveries; the Cassini/Huygens mission is providing stunning views of Saturn and Titan; the Gen-

esis mission has returned primordial samples from space; new missions have been launched to Mercury and comets; amazing discoveries continue with Hubble, Chandra and Spitzer; and we have completed deployment of the Earth Observing System.

- *Laying the Groundwork for the Future*—We have had overwhelming interest in our exploration efforts with 5,000 letters of interest, 600 proposals submitted, and competitive awards of 118 contracts for exploration technologies. Also, initial contracts have been awarded as we prepare for major milestones in 2008 including an unprecedented mapping of the Moon with the Lunar Reconnaissance Orbiter, and a technology demonstration flight of the Crew Exploration Vehicle, and a planned ground-based nuclear reactor test for Project Prometheus.
- *Engaging the Public*—All of these accomplishments have created even greater excitement for space exploration since the President's announcement of the *Vision.* Indeed, the incredible 17 billion hits on NASA web site over the past year is a testament to the intense public interest.

Funding Based on Long-Term Affordability

In his February 2nd State of the Union Address, the President underscored the need to restrain spending in order to sustain our economic prosperity. As part of this restraint, it is important that total discretionary and non-security spending be held to levels proposed in the FY 2006 Budget. The budget savings and reforms in the Budget are important components of achieving the President's goal of cutting the budget deficit in half by 2009 and we urge the Congress to support these reforms. The FY 2006 Budget includes more than 150 reductions, reforms, and terminations in non-defense discretionary programs, of which three affect NASA programs. The Agency wants to work with the Congress to achieve these savings.

To achieve the *Vision for Space Exploration,* NASA is proceeding, as directed by the President, to plan and implement a sustainable and affordable, integrated robotic and human exploration program, structured with measurable milestones, and executed on the basis of available resources, accumulated experience, and technology readiness. NASA views human and robotic explorers as partners in achieving the *Vision.* Last year, we provided a long-range roadmap through 2020 to address how such human and robotic exploration would remain affordable:

- Human explorers would return to the Moon no later than 2020 based on innovative new designs that would be developed in ever increasing capabilities or "spirals." Major development of these hardware elements would commence later this decade, given the retirement of the Space Shuttle in 2010. These exploration elements would include needed launch vehicles, in-space transfer systems, lunar landers and habitation systems, and a Crew Exploration Vehicle (CEV) that would ferry humans from Earth to the Moon and beyond. To prepare for development decisions of these elements, we would use the intervening years focusing on critical research and technology (R&T). Such R&T would encourage new innovations, and ensure development decisions that could deliver hardware at the promised cost and performance. Funding for the R&T this decade was largely achieved by terminating legacy human space flight projects, such as canceling the Space Launch Initiative in last year's budget, and focusing existing R&T investments on exploration requirements.
- Robotic explorers would continue the exploration of the solar system, traveling to places like Mars in anticipation of eventual human visits, and going to destinations that are more challenging, like Mercury, Saturn, Pluto, and comets. Observatories would be deployed to search for Earth-like planets and habitable environments around distant stars, and to explore the universe to understand its origin, structure, evolution, and destiny. Funding for these areas would significantly increase over the coming years with Science investments growing from 33 percent to 38 percent of the Agency's total budget.

These human and robotic explorers will enable our exploration and scientific plans. A recent report released on February 3, 2005, by the National Research Council entitled *Science in NASA's Vision for Space Exploration* states, "Exploration is a key step in the search for fundamental and systematic understanding of the universe around us. Exploration done properly is a form of science. Both robotic spacecraft and human space flight should be used to fulfill scientific roles in NASA's mission to explore."

Guided by Our Priorities

Indeed, the President's FY 2006 budget request for NASA reaffirms the funding strategy outlined above. The FY 2006 budget identifies what is needed to proceed with the transformation of America's civil space program. It maintains resolute focus on key priorities, milestones, and schedules for the *Vision* introduced in the FY 2005 budget:

- First Step—Space Shuttle return-to-flight and completion of International Space Station assembly;
- Flagship Program—Constellation Systems including the 2008 Crew Exploration Vehicle flight demonstration;
- Technology Base—Critical exploration technologies;
- Transforming Technologies—Prometheus Nuclear Systems and Technology, including a planned flight demonstration in a decade;
- Robotic Precursors—Lunar missions beginning in 2008 and Mars missions added in 2011;
- Shuttle Transition—Space Station cargo and crew services via near-term commercial services and Shuttle retirement in 2010;
- Scientific Breakthroughs—Exploration of the solar system and the universe, such as the James Webb Space Telescope launch in 2011 and the search for Earth-like planets.

The FY 2006 budget also supports critical national needs in other areas:

- Aeronautics—Protecting priorities in aviation safety, security and airspace systems and focusing on high-payoff, "barrier-breaking" technology demonstration projects;
- Climate Change—Supporting investments in the Global Change Science and Technology Program and the next generation Earth observing satellites;
- Education—Continuing to inspire the next generation of explorers with programs like Explorer schools and scholarship for service.

To support the Administration's goal of reducing the deficit, NASA's budget was reduced $0.5 billion in FY 2006 below the level planned last year for FY 2006. In addition, returning the Shuttle safely to flight costs $0.4 billion more than previously estimated in FY 2006. To address these and other items the net result was $0.4 billion (11 percent) less in Exploration Systems than previously planned for FY 2006, $0.3 billion (five percent) less in Science, $0.1 billion (11 percent) less in Aeronautics, and $0.2 billion (four percent) more in Space Operations. These changes were not easy but, in the end, we made the tough decisions while protecting the priorities outlined above.

On December 21, 2004, the President signed a new national policy directive that establishes guidelines and implementation actions for United States space transportation programs and activities to ensure the Nation's continued ability to access and use space for national and homeland security, and civil, scientific, and commercial purposes. NASA will play a significant role in implementing this directive, fostering and enabling the development of space transportation capabilities for human space exploration beyond low-Earth orbit, consistent with the goals of the *Vision for Space Exploration.*

Building on Our Scientific Successes

The FY 2006 budget request of $5.5 billion for the Science Mission Directorate will support 55 missions in orbit, 26 in development, and 34 in design phase. By 2010, the Science budget will increase by 23 percent over current levels.

The FY 2006 budget includes $858 million (a 17 percent increase) for Mars and Lunar robotic exploration. The Mars rovers, *Spirit* and *Opportunity,* are exceeding all goals with their unprecedented discoveries and longevity. Last year, they found definitive evidence of an ancient body of water on the Red Planet, and they continue to gather data more than a year after their successful landing. We recently awarded contracts for six instruments to be flown on the 2008 Lunar Reconnaissance Orbiter (LRO) that promises unprecedented mapping of the Moon's surface. The 2008 LRO should revolutionize our understanding of the Moon to the same extent that the Mars rovers have transformed our understanding of Mars.

The budget also includes $218 million to maintain competitive efforts for the Explorer Program, $56 million (a 33 percent increase) for the Beyond Einstein program to study the universe, $234 million for studying the Sun in the Living With a Star program, and $136 million (a six percent increase) for competitive opportunities in the Earth System Science Pathfinder program. With our international partners, we

also continue to add to the constellation of Earth-observing satellites that monitor our planet while extending our reach and presence further into the solar system. We launched Aura to look back at Earth and give us a better picture of our atmosphere and changing climate, and the entire Earth Observing System continues to return trillions of bytes of information about our dynamic Earth. In the future, NASA plans to develop a "sensor-web" to provide timely, on-demand data and analysis to users who can enable practical benefits for scientific research, national policy-making, economic growth, natural hazard mitigation, and the exploration of other planets in this solar system and beyond.

NASA will continue to expand our exploration reach with an armada of existing and new space observatories operating in many different wavelengths and looking at different parts of our exotic universe. The three "Great Observatories"—Hubble, Spitzer and Chandra—will continue to bring wondrous images to our eyes and exciting new scientific discoveries while we continue development of new tools for research like the James Webb Space Telescope and the Space Interferometry Mission that will vastly expand our understanding of the origin and evolution of the universe. Missions such as Kepler will provide a new understanding and knowledge of the planets orbiting stars far from our solar system, perhaps identifying new targets for voyages of exploration by future generations of explorers.

This budget also includes $372 million (a 19 percent increase) to maintain the Webb telescope on pace for a 2011 launch and $93 million in development funds for the Hubble Space Telescope to extend its scientific productivity and initiate a robotic mission to safely de-orbit it. This investment in the Hubble, together with the synergistic use of the other two Great Observatories and combined with the greatly increased capability of ground-based assets and the emergent science of optical interferometry, will ensure many years of new scientific discoveries for the Nation.

NASA decided to discontinue the effort on robotic servicing of the Hubble Space Telescope, and, based on analysis of the relative risks, not to proceed with a Shuttle servicing mission. The Hubble will complete its originally planned 15-year mission this year and, with careful stewardship, should continue to operate for 2–3 additional years until its gyroscopes and batteries wear out. As it ages, other items may unexpectedly fail, such as the recent loss of one of the four scientific instruments, the Space Telescope Imaging Spectrograph (STIS). NASA's decision not to service the Hubble was a very difficult one given the Hubble's spectacular successes. Nonetheless, although the spacecraft may have limited lifetime, NASA is fully committed to saving the associated science. NASA's FY 2006 budget request is consistent with redirecting the HST effort to:

(1) Operate Hubble as long as the spacecraft generates useful scientific data;
(2) Develop techniques to extend its life;
(3) Safely de-orbit the spacecraft after the end of Hubble's useful life;
(4) Examine options for addressing some Hubble science such as re-hosting new or modified Hubble instruments on new space platforms;
(5) Continue analysis of the archived data generated by Hubble; and
(6) Aggressively pursue development of the James Webb Space Telescope, which promises an exciting future of continued discovery.

Even though the *Columbia* accident has compelled NASA to change its plans for the Hubble Telescope, NASA remains committed to our world-class program of astronomy.

Preparing for Our Exploration Future

The FY 2006 budget request of $3.2 billion for the Exploration Systems Mission Directorate includes $753 million for continuing development of the Crew Exploration Vehicle, America's future spacecraft for safe and affordable human exploration, scheduled for a flight demonstration in 2008. The CEV promises safer travel for astronauts into space and continuing U.S. human access soon after retirement of the Shuttle. The CEV as well as launch vehicles for transport of the CEV and cargo to low-Earth orbit, and any ground or in-space support infrastructure for communications and operations, is collectively known as the "System of Systems." This will be developed in a "spiral" approach, wherein early demonstrations and prototypes are used to demonstrate capabilities, validate technologies, and mitigate risk, all along an evolutionary path toward a mature design. The first spiral development planned will provide the capability to deliver humans to orbit in a CEV by 2014. The second spiral will deliver humans to the lunar surface by 2020, followed by the third spiral that will enable extended visits on the lunar surface. As spiral development evolves, System of Systems elements will grow to include in-space support systems, destination surface systems, and additional human support systems. NASA

will be assessing design options for the Crew Exploration Vehicle, including the ability to dock with the International Space Station.

The FY 2006 budget request includes $919 million (a 27 percent increase) for Exploration Systems Research and Technology that will enable designs for sustainable exploration, including $34 million for a revamped technology transfer program and $34 million for the Centennial Challenges prize program. The Agency seeks the Committee's support in providing the authorization language to enable larger prize awards. This budget also includes $320 million for Prometheus Nuclear Systems and Technology to support a new flight demonstration that is less risky and more affordable than the Jupiter Icy Moons Orbiter mission. In addition, the FY 2006 budget request provides $806 million for Human Systems Research and Technology which has been restructured so its programs are now linked directly to exploration requirements for human missions to the Moon, Mars, and beyond.

Enabling Breakthrough Aeronautics Research

The President's FY 2006 Budget fully supports the Aeronautics program's vital research especially in the areas of emissions and noise reduction, increasing the Aviation safety and security, and increasing the capacity and efficiency of the National Airspace System. The budget request also supports the critical research activities that have been identified by the Joint Program and Development Office. NASA's FY 2006 request for the Aeronautics Research Mission Directorate is $852 million. The President's FY 2006 budget increases the Aeronautics program's vital research in Aviation Safety and Security by four percent and Airspace Systems by 32 percent. These two priority programs are fully funded to ensure timely results critical to meeting national goals, especially those efforts in support of the interagency Joint Planning and Development Office (JPDO). This is a consortium of government agencies, of which NASA is a principal member, chartered to transform the U.S. air transportation system by the year 2025.

Participants include Departments of Defense, Homeland Security, Commerce, and Transportation.

To ensure maximum benefit to the taxpayer, we are transforming part of our investment in Aeronautics Research in order to more sharply focus the investment on breakthrough technologies. Toward this end, the NASA Aeronautics Vehicle Systems Program has been restructured from the current emphasis on numerous projects aimed at incremental improvements. Instead, the program is moving towards a smaller and more focused set of four projects seeking to achieve near-term flight demonstrations of revolutionary and barrier breaking technology: (1) reducing the noise of conventional aircraft to within the airport boundary, (2) reducing the supersonic boom allowing future supersonic aircraft to fly over land without the restrictions in place today, (3) developing electric propulsion systems for aircraft that eliminate pollution entirely because they do not burn hydrocarbon fuels, and (4) demonstrating high altitude, long endurance, remotely operated or autonomous aircraft to create opportunities for new applications including scientific platforms. The $459 million program request for FY 2006 will fully fund these four projects. In concert with the Agency transformation, this program will be conducted using a higher level of competitively awarded research. We believe that this new focus and new way of performing the research will enhance the value of our vehicle research to the taxpayer.

Meeting Our Obligations

The FY 2006 budget request of $6.8 billion for the Space Operations Mission Directorate reflects the first step in the *Vision:* returning the Space Shuttle safely to flight and resuming flight operations. The budget includes $4.5 billion to return the Shuttle safely to flight and maintain safe operations in support of five planned flights. NASA will retire the Space Shuttle in 2010. The FY 2006 budget also provides $1.9 billion for the International Space Station. NASA currently is examining configurations for the Space Station that meet the needs of the *Vision for Space Exploration* and our international partners and require as few Shuttle flights as possible to complete assembly. A key element in the future of the International Space Station program is the purchase of alternate cargo and crew transportation services to supplement the Shuttle when it is in service, and to replace it when it retires. The budget provides $160 million for these services in 2006 and NASA intends to solicit a Request for Proposal for commercial cargo transportation services to the Station this summer.

We are making final preparations to return the Space Shuttle safely to flight in 2005. We have made more than 100 major maintenance modifications and upgrades to *Discovery* and its supporting systems, including new cabling and wiring that will support leading edge sensors, a digital camera, and a boom extension for the Shut-

tle's robotic arm that will enable us to inspect nearly all the outside areas of the orbiter's Thermal Protection System during missions. Technicians installed the Forward Reaction Control System and the Reinforced Carbon-Carbon Nose Cap, and 88 sensors are being installed on each wing; 66 will measure acceleration and impact data, and 22 will take temperature data during *Discovery*'s journey. Overall, we are making excellent progress on the milestones toward a launch. The return of the Shuttle to flight is a key milestone and we are committed to keeping human space flight as safe as possible.

As the United States implements the *Vision for Space Exploration,* the Administration recognizes the value of effective cooperation with Russia to further our space exploration goals. At the same time, we have to appropriately reflect U.S. nonproliferation policy and objectives in our relationship with Russia. The Administration is thus interested in seeking a balanced approach that continues to protect our nonproliferation goals while advancing potential U.S. cooperation with Russia on the *Vision for Space Exploration.* Such a balanced approach must include the Iran Nonproliferation Act of 2000 (INA), which currently complicates cooperation with Russia on the International Space Station (ISS), and will also have an adverse impact on cooperation with Russia on our future space exploration efforts related to human space flight. To that end, the Administration looks forward to working with Congress to ensure that the Vision for U.S. Space Exploration is able to succeed while remaining fully consistent with broader U.S. national security and nonproliferation goals.

This year, we began our fifth year of continuous astronaut presence on the Space Station. Astronauts continued their international cooperation on-board the Station through a variety of joint research activities. Just last month, agency leaders from the U.S., Russia, Japan, Europe, and Canada met in Montreal, Canada to discuss Station cooperative activities. At the meeting, the Station partnership unanimously endorsed completion of this orbiting laboratory by the end of the decade.

Building the Pipeline for Future Careers

The FY 2006 budget request of $167 million for the Office of Education reflects NASA's continued commitment to developing the next generation of explorers by inspiring and motivating students and educators at all levels in the formal and informal education communities to pursue careers in science, technology, engineering, and mathematics. We will achieve this goal by providing unique teaching and learning experiences, as only NASA can, through the Agency's research and flight missions. Students and educators will be able to work with NASA and university scientists to use real data to study Earth, explore Mars, and conduct scientific investigations. They will work with NASA engineers to learn what it takes to develop technological breakthroughs required to reach the farthest regions of the solar system and to live and work in space. To ensure diversity in NASA's future workforce, the education programs pay particular attention to under-represented groups. NASA will continue to support the Nation's universities to educate more students in science and engineering by providing meaningful research and internship opportunities for qualified students, plus a roadmap for students seeking NASA careers. The FY 2006 budget continues emphasis on priority initiatives: NASA Educator Astronaut, NASA Explorer Schools, NASA Explorer Institutes, and Science and Technology Scholarship Program. Exploration advances knowledge.

The Vision is Transforming NASA

To achieve the *Vision for Space Exploration,* NASA is engaged in a major transformation—taking the extraordinary capabilities we have throughout the Agency and restructuring them to achieve the goals of the 21st century. This is an enormous challenge, but in less than a year, we have begun to transform our entire organization to foster permanent change and making a positive, mission-driven culture. We are creating an environment of openness and free-flowing communication by continuing to assess our leadership practices. We also are sure that the entire NASA family is headed in the same direction.

The focus of the transformed NASA is on how best to achieve the *Vision* and other national priorities assigned to our Agency. Guided by NASA's core values of Safety, the NASA Family, Excellence, and Integrity, the Agency's transformation is:

- *Embedding a Safety Culture*—NASA is continuing to foster its safety culture throughout the organization. The Agency has reduced workforce accident rates to industrial world-class standards and implemented an Independent Technical Authority (ITA) and NASA Engineering and Safety Center (NESC) to guide NASA's continued safety improvements. NASA's FY 2006 budget assumes $87 million in Center service pool budgets to support the ITA func-

tions. The budget also includes $79 million for the NESC (a 21 percent increase).

- *Embracing Competition*—NASA is embracing competition as a way to elicit the best from the NASA's Centers, industry, and academia. The Agency is using competitive processes to encourage more cost-effective, innovative solutions to the scientific and technical challenges presented by the Vision. Over the past year, competitive selections in exploration have demonstrated increased collaboration between NASA's Centers and industry and academia. The budget provides well over $10 billion in new competitive opportunities over the next five years.
- *Enhancing Strategic Planning*—In a new document released with our FY 2006 budget request, *The New Age of Exploration: NASA's Direction for 2005 and Beyond,* we outline NASA's commitment to change and to achieving the *Vision.* This document establishes NASA's long- and short-term objectives, supports our re-mapped FY 2005 Performance Plan, and underpins the structure and strategy of our FY 2006 budget. NASA's 2006 Strategic Plan—to be released next February with the FY 2007 budget request—will be informed by the strategic and capability roadmaps currently being developed by national teams of experts from academia, industry, other government agencies, and NASA.
- *Improving Decision-making*—Our transformed headquarters organization includes a Strategic Planning Council and a supporting Advanced Planning and Integration Office to enable better long-range planning, an Operations Council to integrate NASA's tactical and operational decisions, and a transformed NASA Advisory Council to integrate Agency activities. We have streamlined our corporate structure by reducing the number of headquarters organizations by half to four Mission Directorates and eight Mission Support Offices.
- *Reinvigorating Field Centers*—NASA has identified Core Competencies, involving human capital and physical assets, which must be sustained within NASA in order for the Agency's mission to be achieved. These specific Organizational Core Competencies are resident at one or more NASA Centers and funded primarily through competitive means. Every three years, these Competencies will be assessed as a part of the Agency's strategic planning process, and may be changed in response to changing mission requirements, emerging commercial capabilities, and/or competitive results. NASA's Centers will build long-term business plans based on the *Vision for Space Exploration,* strengthen institutional capabilities around Core Competencies, and remain at the cutting edge through competitive opportunities. NASA Centers will also be examining alternative management structures to enhance organizational agility and to foster new business opportunities.
- *Transforming Human and Physical Capital* —As NASA sets its sights on exciting worlds beyond, NASA will require a workforce and facilities with the right mix of world-class capabilities. The Agency is actively engaged in a multi-faceted approach to shape the workforce of the future, and to align it physical assets in support of current and future mission needs. The need to reshape workforce and align physical assets is not a new challenge for NASA, but with the Vision we are now provided the necessary long-term direction to guide the transformation. In response to all these challenges, NASA will use 2005-2006 as a transition period for Centers to reshape and rebalance its workforce and facilities. The Agency is undertaking a number of targeted workforce activities to ensure the relevant skills are available to accomplish the mission. Additionally, it is taking steps to identify underutilized infrastructure that could possibly be replaced with state-of-the-art facilities providing greater utility or a lower cost burden to the Centers. Before closing any facilities, NASA will be coordinating with other users and government agencies to determine the demand for underutilized facilities. In the near future, NASA will be proposing a set of legislative initiatives as part of the Agency's draft Authorization Bill that will enhance the Agency's transformation in support of the *Vision.*
- *Implementing Improved Program Management Procedures*—The Agency is implementing improved cost estimating and earned value management procedures to ensure we meet our cost commitments. We are also establishing an acquisition strategy approval process that will draw on the best processes from the Department of Defense and prior NASA acquisition policies. This is to ensure that before contract award, all acquisition programs and projects will satisfy the requirements and that the acquisition strategies, if done as

planned, are executable, have exit and entrance criteria, contain clear approval milestones, and involve independent reviews.

- *Improving Financial Management*—For the past two years, NASA has received a disclaimer of audit opinion on its annual financial statements due largely to two issues—financial system conversion, and accounting for property, plant and equipment, and materials and supplies. In FY 2003 NASA converted the 10 separate NASA Center accounting systems and the associated 120 subsidiary systems, along with over 12 years of historical financial data, into one single integrated agency-wide core accounting system. Problems associated with this conversion have been greater than expected and are taking longer than expected to correct. Accounting for property and materials and supplies valued at $37.6 billion (83 percent of NASA's assets on the balance sheet) lacks the necessary internal controls and systems to support valuation for management and audit purposes. NASA understands the seriousness of these issues and has developed work plans to overcome these and other material issues, however it will take time to implement all of the corrective actions. NASA anticipates that improved audit results could be achieved on the FY 2006 financial statements with a reduction in the number of material weaknesses and reportable conditions.

The Nation's Future in Exploration and Discovery

The torch is being passed from the pioneers, who first took us to the Moon and beyond, to the new generation of explorers who will take us into deep space to stay. A new era in space exploration begins with the return-to-flight of the Shuttle and the completion of the International Space Station, as we begin a journey that will take the next generation of Americans back to the Moon, to Mars, and beyond. We will also be pursuing ever more aggressive plans with advanced robots and space observatories that will require this nation's most sophisticated technical capabilities.

This generation inherited great legacies from the exploratory voyages and discoveries of earlier centuries. It is our responsibility to ensure that future generations inherit from our journey a similar legacy of achievement and inspiration. Implementing the *Vision* will provide this legacy. The FY 2006 NASA budget reaffirms the President's commitment and allows us to take the next step in implementing the *Vision*.

As President George W. Bush said, "We choose to explore space because doing so improves our lives and lifts our national spirit. So let us continue the journey."

BIOGRAPHY FOR FREDERICK D. GREGORY

Frederick D. Gregory is the Deputy Administrator of NASA. He assumed this position in August 2002. He serves as the Chief Operating Officer for the Agency and reports directly to NASA's Administrator. He is responsible for directing and managing many of the programs as well as the day-to-day operations and activities at NASA.

Prior to becoming the Deputy Administrator, Mr. Gregory served as the Associate Administrator for Space Flight and was responsible for overseeing the management of the International Space Station; Space Shuttle operations; Space Access using Expendable Launch Vehicles for commercial launch services; Space Communications; and Advanced Programs. He held that position from December 2001 to August 2002.

From June 1992 to December 2001, Mr. Gregory held the position of Associate Administrator, Office of Safety and Mission Assurance, at NASA Headquarters. As Associate Administrator, he was responsible for assuring the safety, reliability, quality, and mission assurance of all NASA programs.

Mr. Gregory has extensive experience as an astronaut, test pilot, and manager of flight safety programs and launch support operations. As a NASA astronaut, he logged 455 hours in space: as pilot for the Orbiter *Challenger* (STS–51B) in 1985, as spacecraft commander aboard *Discovery* (STS–33) in 1989, and as spacecraft commander aboard *Atlantis* (STS–44) in 1991. Mr. Gregory served in several key positions as an astronaut, including Astronaut Office Representative at the Kennedy Space Center, for the first Space Shuttle flights (STS–1 and STS–2); lead Capsule Communicator (CAPCOM); Chief, Operational Safety at NASA Headquarters; and Chief, Astronaut Training. He also served on the Orbiter Configuration Control Board and Space Shuttle Program Control Board.

Mr. Gregory retired as a Colonel in the United States Air Force in December 1993 after logging 7,000 hours in more than 50 types of aircraft, including 550 combat missions in Vietnam. His 30-year Air Force career included serving as a helicopter pilot and as a fighter pilot. He graduated from the United States Naval Test Pilot

School and served as an engineering test pilot for the Air Force and for NASA. He was selected as a pilot Astronaut in January 1978.

Mr. Gregory holds a Bachelor of Science degree from the United States Air Force Academy and a Master's degree in Information Systems from George Washington University. He is a member or past member of numerous societies, including the Society of Experimental Test Pilots, American Helicopter Society, Air Force Academy Association of Graduates, the National Technical Association, the Tuskegee Airmen, and the Order of the Daedalians, and the Association of Space Explorers. He has been or currently is a board member with the following organizations: Maryland Science Center; Young Astronaut Council; Kaiser-Permanente; the Photonics Laboratory at Fisk University, and the Engineering College at Howard University.

His honors include the Air Force and DOD, Meritorious Service Medal, Air Force Commendation Medal, 16 Air Medals, two Distinguished Flying Crosses, Legion of Merit, Defense Superior Service Medal, Defense Meritorious Service Medal, National Intelligence Medal; NASA, three Space Flight Medals, two Outstanding Leadership Medals, Distinguished Service Medal; National Society of Black Engineers Distinguished National Scientist Award; the George Washington University Distinguished Alumni Award; President's Medal, Charles R. Drew University of Medicine and Science; Honorary Doctor of Science Degrees from the College of Aeronautics and the University of the District of Columbia. He was also awarded the Air Force Association Ira Eaker Award as well as numerous civic and community honors.

He is married to the former Barbara Archer. They have two children and four grandchildren.

DISCUSSION

Chairman BOEHLERT. Thank you very much, Mr. Gregory, and let me tell you, this committee, on a bipartisan basis, was privileged and proud to work with you and all at NASA to get that Workforce Flexibility Act in place, to give you the flexibility you need to treat your staff the way it should be treated, as very able professionals.

As I mentioned in my opening statement, there are a lot of questions NASA can't answer yet. And I understand that. I am going to go through a list of nine items, and for each of them, I would like to know when NASA will be able to give Congress an answer to the question. It would be helpful to know a month, but a season will do. I will stop after each item.

ISS RESEARCH

First question. The research agenda for the Space Station.

Mr. GREGORY. I would say that the research agenda, at least the first part of it, should be available at the end of this month, or early in March, but if it is okay with you, let me ask Mr. Craig Steidle, who is responsible for that, to give you——

Chairman BOEHLERT. Admiral.

Mr. GREGORY.—a more definitive answer.

Admiral STEIDLE. Yes, sir. Thank you.

We will complete the assessment that we have under way by the 28th of February, and I will give it to Bill Readdy, who—and then together, we will put it together, and have a completion of that study at the end of April.

Chairman BOEHLERT. Thank you very much. Next question. Whether the Space Station will be reconfigured once again, whether we will bring up the centrifuge.

Mr. GREGORY. The—about three weeks ago, we had the privilege of meeting in Montreal with the heads of agency, that would be the Sean O'Keefe equivalent in Japan, Canada, Europe, and Russia.

Chairman BOEHLERT. Or the Fred Gregory equivalent, come Sunday.

Mr. GREGORY. Thank you, sir. I have had the privilege of chairing something called the Multilateral Coordination Board, which is the board just down from—the representatives just down from the top. During that session, we looked at the, and agreed to, the final configuration of the International Space Station. We made a recommendation to the heads of agency, which they accepted.

As part of that configuration, we looked at the assembly sequence, and we looked at the number of flights that could accomplish that configuration. At the same time, however, with the change in—with the identified focus that we have now, as part of the Exploration Vision, we also held open the opportunity to re-evaluate the components that we will have on the International Space Station. This was very openly addressed with the international partners, and each has taken upon themselves, and given themselves the opportunity re-look at what they are—what they would have on the Space Station.

We, of course, are focused toward the Exploration Vision. It is a requirement-driven activity that we have, as we assess each and every piece and component, as it prepares us to take the next step.

Chairman BOEHLERT. So when will we be enlightened? A season, at least?

Mr. GREGORY. Well, Admiral Steidle gave you that answer just a moment ago. He said that they would report out at the end of February, and that probably by the end of April, all of us will know, sir.

REMAINING SHUTTLE FLIGHTS

Chairman BOEHLERT. Okay. The number of remaining Shuttle flights planned.

Mr. GREGORY. The—at this moment, we are looking at a number that is around 28. But as I said earlier, what we are looking at is the fewest number of flights necessary to complete the International Space Station with its requirements by December 31, 2010, as you mentioned.

But let me have Bill Readdy give you his opinion.

Chairman BOEHLERT. Mr. Readdy.

Mr. READDY. Thank you, Mr. Chairman. 28 flights is the baseline manifest, as agreed to by the international partners, but as a result of the *Vision for Space Exploration,* we are taking a very critical look at that, and what components will be flown, and as Mr. Gregory and Admiral Steidle both said, by the end of April, we should have a little bit more clarity in terms of perhaps some of the content for that.

We don't want to use the Space Shuttle for any more flights than we have to, where its unique capabilities to carry modules to the International Space Station, to support spacewalks, to support robotic operations, and crew transfer, and logistics. We don't want to use that for any more flights than we have to to complete our obligations.

Chairman BOEHLERT. Thank you very much. So by the end of April, we can expect something more definitive?

Mr. READDY. In terms of the centrifuge, that is correct, sir.

Chairman BOEHLERT. And what about the number of flights?

Mr. READDY. The number of flights will be an iterative process with our international partners and ourselves, as we assess what our exploration goals are, and as they assess what their exploration goals are. So expect—that will be a continuing dialogue, but the first step in the *Vision for Space Exploration,* of course, is returning the Space Shuttle safely to flight, and we are very focused on doing that right now in late Spring.

Chairman BOEHLERT. So it is still an open question on the number of flights, as you point out.

Mr. READDY. Yes, sir. I think it will be an open question, and it will certainly be dependent on how we fare with return-to-flight, and the remainder of the flights this year, and input that we get from the international partners.

Chairman BOEHLERT. Well, let us go on down to the manifest for the Shuttle flights. That is, which flight will conduct which mission? Has that been determined yet?

Mr. READDY. Yes, sir. At least in the baseline manifest, each and every one of those 28 flights has been laid out, with specific mission objectives, and that is how we pared it down initially, to meet our international commitments. We are assessing each and every one of those flights, and General Kostelnik and his Space Station Deputy, Mark Uhran, and the Program Manager, Bill Gerstenmaier, are looking at all of those flights to see which ones are uniquely requiring the Space Shuttle as a launch capability.

As you know, we are also looking at commercial crew and cargo to the International Space Station this fiscal year. We look for the opportunity to be able to provide logistics with other than Shuttle, certainly after it is retired at the end of this decade, but to that end, this summer, we expect to have a request for proposal issued, and then by the end of this calendar year, we expect to start issuing contracts to that end.

Chairman BOEHLERT. Whether NASA will have to lay off employees this year or next. Mr. Gregory.

Mr. GREGORY. The answer to that is very clear, and that is between now—this year and next, there will be no employees laid off. We have adequate budget to cover all salaries for the next year and a half or so, or the next two years. During that time, we will be assessing, in a very deliberate way, based on the Vision that we have, the kind of requirements that we have, and the kind of resources that will be necessary, and that includes people and facilities and capabilities, sir.

PROJECT PROMETHEUS

Chairman BOEHLERT. What mission will be used as a test for Project Prometheus?

Mr. GREGORY. Craig Steidle.

Admiral STEIDLE. Yes, sir.

Chairman BOEHLERT. Admiral.

Admiral STEIDLE. Yes, sir. Did you say vehicles, sir, or——

Chairman BOEHLERT. What mission?

Admiral STEIDLE.—test mission? Which mission? We don't know exactly what the mission will be to demonstrate Prometheus, but we are doing an analysis of alternatives to define exactly that.

On Prometheus in general, we looked at the risk and the scope and the dollar value of the JIMO mission that was proposed. After we signed the MOU with Naval Reactors through its Department of Energy hat, we did an assessment of that particular mission, found that we were pushing the state of the art for what we were trying to achieve in the JIMO mission, so we looked at some earlier spirals, earlier demonstrations of fuel capabilities, probably in '08, demonstration of a prototype in '11, and hopefully, for a mission by—within the—another decade. We haven't defined exactly what that mission will be, but it will be a demonstration of an in-space nuclear electric capability, a joint exploration and science mission.

CREW EXPLORATION VEHICLE

Chairman BOEHLERT. Thank you very much. The basis parameters for the Crew Exploration Vehicle, including the crew size and whether it could service the Space Station.

Mr. GREGORY. The RFP for that will go out, I believe, the first week of March. We anticipate a response back, and a selection in the August timeframe, and let me, again, give Mr.—Admiral Steidle the opportunity to talk about that area.

Chairman BOEHLERT. Admiral.

Admiral STEIDLE. Yes, sir. Mr. Chairman, what we have done, slightly different, is we have tried to leave the trade space open as wide as we possibly could, first thing. And we tried to get as much participation with industry as we could in the early design and scope of the concepts.

Chairman BOEHLERT. That is to be applauded.

Admiral STEIDLE. Yes, sir. So what we—thank you—what we did is we led a Broad Agency Announcement, and we picked 11 teams. They go from the traditional primes down to t/Space, and some of the nontraditional players, and brought them into the fold, actually working with us to define the requirements, and helping us write the RFP. So we have kept that trade space open. The final version of the RFP will go out by the 1st of March, with a selection, as Mr. Gregory said, in August. We are going to keep that trade space open through about the summer of '06, when we will define with more rigor such parameters and capabilities, such as the number of crew, and the launch vehicles, and pieces of that nature.

NASA'S PROPOSED IRAN NONPROLIFERATION ACT REMEDY

Chairman BOEHLERT. NASA's plan for dealing the Iran Nonproliferation Act.

Mr. GREGORY. I appreciate that question. As we all work to accomplish the President's *Vision for Space Exploration,* we recognize that this is a journey for all mankind, and as with endeavors such as the International Space Station, the cooperation of international partners will be welcome.

I can tell you from personal experience we have worked very, very closely with the Russians, and I will tell you, it has really surprised me how close these two countries have come, and how they have certainly exceeded our expectations. There have certainly been challenges. There are always challenges in programs such as this. But we recently accomplished something called a balance

agreement, which preceded the INA activity, or the INA Act. And we are now very comfortable with the ability to maintain and sustain a human presence, both American and Russian, on the International Space Station through April 2006. It includes transfer, crew transfer both ways, and Station crew rescue capabilities.

The Administration is interested in seeking a balanced approach that continues to protect our non-proliferation goals while advancing potential U.S. cooperation with Russia on the Vision for U.S. Space Exploration. Such a balanced approach must include the *Iran Nonproliferation Act of 2000,* which is the INA, which currently complicates the cooperation with Russian on the International Space Station, and we also have to address the impact on cooperation with Russia on our future space explorations, efforts related to human space flight. To that end, the Administration looks forward to working with Congress to ensure that the Vision for the U.S. Space Exploration is able to succeed while remaining fully consistent with broader U.S. national security and non-proliferation goals.

Chairman BOEHLERT. So when will we know? We welcome their cooperation in space exploration, and applaud that. I would like to see that same cooperation——

Mr. GREGORY. It is——

Chairman BOEHLERT.—with nonproliferation.

Mr. GREGORY. This is a very critical decision, that has to be made, and an agreement and understanding. I can't tell you yet what the form of it will be, but I do know that NASA, along with the Administration and the Department of State, are working diligently to prepare, so that we can engage with the Congress to come to an understanding. I would say that it would be sooner rather than later, and if you will allow, when we get greater detail, we will report back to you, sir.

LAUNCH VEHICLE FOR THE CREW EXPLORATION VEHICLE

Chairman BOEHLERT. And finally, the launch vehicle for the CEV.

Mr. GREGORY. Let me give—again—this to Admiral Steidle.

Chairman BOEHLERT. Admiral.

Admiral STEIDLE. Yes, sir. What we have done, sir, is taken a step back, and I will get to answer in just a second. But what we have done is pulled out all of the trade studies that have been done from launch vehicles. We worked together, Bill Readdy, myself, and our Director of Mission Safety and Analysis, Brian O'Connor, to redefine the human ratings plan and human ratings document.

We have—are going to share that with the industry. We are going to complete our trade studies, and present the capabilities to industry right after we put the RFP out, and that will be in April, so that is the capability that is going to be required for the Crew Exploration Vehicle.

During the summertime, when we select the two teams that will actually build the demonstration model and go forward, we will share with them the human ratings document and plan, so that we can integrate this as a total system. We will also go out with an RFP for a launch vehicle to support the Crew Exploration Vehicle.

In the December timeframe, we should have the selection of the Crew Exploration Vehicle launch vehicle.

Chairman BOEHLERT. Thank you. I have exercised the privilege of the chair by going beyond my normal five minute question period, but these are questions that are on the minds of all of us on this committee, on both sides of the center aisle. And from the answers, and some of those, understandably, were somewhat vague, you can appreciate why we are having this hearing, and are determined to follow through and work cooperatively with you to ferret out the answers, so that we can make some decisions based upon fact, rather than just theory, or for that matter, emotion.

We all are excited by space exploration, and I was one who was there when the President gave his January 14 speech last year. I stood and applauded, because he inspired us all. He outlined a vision, and to his credit, he didn't say we are going to do it tomorrow, and Congress, write me a blank check. But he did indicate a determined effort to explore the great beyond, and that is something we all are interested in.

Mr. Gordon.

Mr. GORDON. Thank you, Mr. Chairman. That was an important line of questioning. Over the last few years, we have been given a lot of wait and see type answers, and I think it is important that we do set some deadlines, and I will try to be brief, to make up for your lack of brevity here, because you served us all with those questions.

SOYUZ AND THE IRAN NONPROLIFERATION ACT

Now, Mr. Gregory, the last Soyuz we have contracted for goes up this year. And so in terms of timetables, next year, either we are going to have—the President is going to have to certify compliance, or there is going to have a repeal of the Non-Proliferation period—Treaty. Is that correct?

Mr. GREGORY. Sir, would you repeat the question——

Mr. GORDON. Yes.

Mr. GREGORY.—one more time?

Mr. GORDON. Since the last Soyuz is going to be going up this year, that we have contracted for, they have agreed to do, and we have no alternative method, then next year, and the Russians have made it clear, over and over, that they are not going to do it at their own expense, then so next year we are going to—the President either has to certify compliance or there is going to have to be some type of repeal of the Iran Non-Proliferation Treaty. Is that correct?

Mr. GREGORY. Sir, you are correct that we have an agreement with the Russians for them to carry out the crew transfer and the rescue. As I had stated earlier, it is vital that an agreement be reached on how we handle the INA. That is still being discussed on the Administration's side, and as soon as we are aware of the medium with which we will approach Congress, we will come back. From my point of view, it is essential, it is mandatory, and it will set us up to continue the build and completion of the International Space Station.

Mr. GORDON. Now, the Russians have made it clear, they have said over and over, they are—that they are not going to do this on

their own. So if that is the case procedurally, then, if we have to—and we have no alternative but to purchase additional Soyuzes next year. Then the only alternative, is this correct, that either the President has to certify compliance, or there has to be repeal or modification of the Act? Is that correct?

Mr. GREGORY. Something will have to occur, yes.

Mr. GORDON. I know that. Right. But would it have to be one of those—is it—is there anything other than one of those two alternatives?

Mr. GREGORY. At this moment, I am aware, perhaps a waiver or an exception. Other than that, sir, I am—I don't know what the other vehicles would be.

Mr. GORDON. There is a waiver or something. Could you—then, could you lay out—would you provide for the Committee, please, what those alternatives would be?

Mr. GREGORY. Sir, if we would allow—we will provide that for the record, as soon as——

Mr. GORDON. Right.

Mr. GREGORY. As soon as we learn.

Mr. GORDON. Well, you don't know? I am not asking you what the President is going to do. I am asking you what are the alternatives the President can do?

Mr. GREGORY. Well, those——

Mr. GORDON. Those should be known, shouldn't they?

Mr. GREGORY. Well, those are the two that I can speak of at this moment. But if you would allow, I will research and provide it for the record.

NASA WORKFORCE

Mr. GORDON. Again, I am not—I know that you, you know, don't have ESP. You can't know what the President is going to do, but you—he, I assume he is going to ask you what are the alternatives, and that is what we would like to know, what the alternatives and what the timeframe would go with that. Let me ask you, also, approximately how many employees does NASA currently have? Just approximately.

Mr. GREGORY. Jim Jennings, can you give us an answer?

Mr. JENNINGS. Yes. We have approximately 18,000 employees in NASA today.

Mr. GORDON. And what does your five year budget assume for the workforce levels over the next five years?

Mr. JENNINGS. Our current budget, we are budgeted through '07 for the 18,000 employees. Going into '07, we are budgeted for about 2,000 less than that, and over the next two years, we are going to work to understand our exploration program, and where that competition lies, and our assumption is we will remain close to the 18,000 during the—through the run-up.

Mr. GORDON. I thought you said there were going to be 2,000 less. And you can't take 2,000 off, and then still have 18.

Mr. JENNINGS. Our current budget planning is 2,000 less beginning in '07, but we have a lot of work that hasn't been defined in the exploration program. Our expectation is, over the—during this budget process, that work will be defined, and then, we can assign folks in the center to that fund.

Mr. GORDON. But you can't put—you can't really have an accurate five year budget without knowing what your workforce level is going to be.

Mr. JENNINGS. The process we go through, we define the mission, and then we look at and see what human resources is required to carry out that mission.

Mr. GORDON. Well, that means you are going to be getting rid of current employees that don't meet your—the mission, and bring in additional employees that will have the skills and talents.

Mr. JENNINGS. That will be part of the process, looking at our skill mix issues, but to answer the question, as we put the budget together, we didn't have a lot of the exploration vision defined, so we couldn't assign those employees at centers to it. So as we define those, we will assign the folks at the centers to that particular dollar lines.

BUYOUTS

Mr. GORDON. And you have advertised buyouts at a number of the centers. Can you tell us how many employees you are hoping to take the buyouts and how many actually took the buyouts?

Mr. JENNINGS. The current buyouts that we had planned, this year, we had hoped to get about 425 employees to take those buyouts. We got about 325. We are offering the buyout again across the Agency, and we hope to get about the same number in this new buyout.

Mr. GORDON. Let me compliment you for—its—we don't often get specific information here, and I thank you for helping us with that.

Mr. Gregory, the NASA briefing charts indicate that NASA has a team looking at, and I quote "transformation to alternative organizations, such as Federally-Funded Research and Development Centers, and further consolidations with additional facility closures." In other words, privatizing the NASA centers or shutting down some of the facilities. Could you give the Committee specifics on what is being planned?

Mr. GREGORY. Certainly, sir. Well, first of all, as you look at the—if you look at the exploration vision, the exploration vision is probably the largest sustained activity that I am aware of, certainly nothing like this has ever occurred in the government, and probably in industry. As you transform and prepare yourself to look forward, and to sustain an activity like this, it requires changes. It is absolutely mandatory that changes occur. As we have reorganized the headquarters to bring together the themes that we have in order to support, it also requires that we look at the skill mix that we have in the agency. It looks at how we get the best bang for the buck. We are all taxpayers. We want that—the monies that come to us to be spent in a very reasoned way.

It also requires that not only do we look at the skill mix, but it also requires that we take a look at the facilities that we have, and there are activities where we look not at closing down centers at all. That is not part of it. But looking at those resources that we have, assets that we have, to determine what is necessary, both in the short term and the long-term, that we should either maintain, upgrade, shut down, and rebuild. Another thing we are looking at are management organizations. You mentioned the FFRDC, the

Federally-Funded Research and Development, but that is one of many alternatives that we are looking at, a university affiliate, industry partnerships, government institutes of sorts. And so we have actually asked each center director to evaluate what they do, and determine what are those obstacles, or those hindrances, to do even greater work.

And so each center is looking at them, and there was a team put together that came up with several options, but I think it was very clear, as the team worked together, that there was not a single solution, that it could be one of several, that it would not necessarily replace, but might complement. And so all of those activities are going on as the Agency transforms itself to support the exploration vision.

Mr. GORDON. Thank you, Mr. Gregory. My time is running out. But let me just say it was almost staggering, in terms of magnitude, that you described the changes that are getting ready to go on. This is sort of the genie going out of the box here. That is why we really would like to be partners with you in trying to determine where NASA is going, because there is the potential to lose a tremendous amount of skill and employees, and institutional knowledge that can't be replicated. And so we have got to be sure that we are going the right direction, and a sustainable direction, because the magnitude that you pointed out, there is no turning back.

Mr. GREGORY. Yes, sir. And I certainly agree with you, and that is why, as Mr. Jennings just mentioned, we have several years to thoroughly assess and make a reasoned—or give you a reasoned answer. No rash decisions at all, as far as I can tell, and I think that you will be very satisfied and pleased with the way the Agency responds to these very important questions.

Mr. GORDON. It sounded like two or three years was—I don't know whether that is several, but it was—there is going to be some pretty big things happening in two or three years.

Mr. GREGORY. Until 2007, we have stability.

Chairman BOEHLERT. Thank you. The gentleman's time has expired, and I want to commend the gentleman from Tennessee, who has proven that Democrats are as loquacious as Republicans, and just as constructive and productive in the line of questioning.

Mr. Calvert.

SPACE SHUTTLE FLIGHT MANIFEST

Mr. CALVERT. Thank you, Mr. Chairman. Thank you, Mr. Gregory, for your testimony.

I guess this question is for both you and Mr.—and Admiral Steidle. You mentioned that approximately 28 missions were necessary to finish the International Space Station, and as we all know, when we look at the budget for NASA, the first thing that strikes you, of course, is that the Shuttle and the Station itself take up approximately 40 percent of the overall budget. So in order for us to move on to the President's vision, we need to stay on budget and finish the Station as soon as possible.

Of the flights that are going to Station, how many are solely for the assembly of the International Space Station, and how many are purely supply missions?

Mr. GREGORY. As is usually the case, all Navy guys look the same. It was actually Bill Readdy, also a Navy person, who would be the appropriate person to answer that question.

Mr. CALVERT. All right.

Mr. READDY. Thank you, Mr. Calvert. The 28 flight manifest is a mix of some modules going up and logistics, and so you can't necessarily take one mission and say, okay, that is a logistics mission solely, because each and every mission is going to carry some logistics. Not every mission is dedicated to a particular cargo element. So there is some logistics and some assembly in most of those flights.

I will get you the answer for the record, because we are assessing the mission content from that 28 flights and working backwards, based on our exploration vision.

ALTERNATIVES FOR INTERNATIONAL SPACE STATION CONSTRUCTION

Mr. CALVERT. The reason I was asking that question, are there alternatives—and some testimony that indicated that there was—besides the Shuttle. Obviously, the Shuttle is an expensive infrastructure to maintain, but the sooner we get the Station done, the sooner we could retire the Shuttle. Is there—have you looked into other lifting components to—that would be able to lift these components and get this done sooner?

Mr. GREGORY. Yes, sir, we have. And just to set the stage here, the International Space Station right now, that is on orbit right now, circling the world every hour and a half, is about half-built. It is about the size of a 747 jumbo jet. The solar arrays have got about the same wingspan as a 747, about the same habitable volume. Most of the other components are at the Kennedy Space Center, and they have already been integrated into launch packages, and they are ready to go, with the exception of the Columbus Laboratory that the Europeans are providing, which is over in Bremen, Germany, and some other components. So——

Mr. CALVERT. Have you looked into if, in fact, basically, the components that are on the shop floor, and it is a matter of getting these components up and constructing the Station to its—to completion, if in fact, we resolve our issues with Russia and the Iran proliferation problem that we have to work out, could they be helpful in getting this done sooner by using some of their lift capability?

Mr. GREGORY. We have already looked at the ability to use other launch vehicles, and because those launch packages, those modules were designed to be launched on board the Space Shuttle, the launch environments, the loads, the integration of those different packages doesn't allow you to repackage those for a different launch vehicle, with different interfaces, without substantial redesign. So we don't think that that is possible. It may be that by adjusting the manifest, there are some components of the International Space Station that, based on our new exploration vision, and that of our partners, may no longer fit in the assembly sequence, though.

CREW EXPLORATION VEHICLE DEVELOPMENT

Mr. CALVERT. Going back to the CEV for a second, Admiral, you mentioned in your testimony in answering a question that determining at this point exactly how that vehicle is going to be comprised and moved forward, it seems me, I am new to this Chairmanship. I have been here two weeks, but I have been on the Committee 12 years, that we haven't had a lot of great success in working out the—a new launch vehicle. Can you make us more comfortable up here, what new emerging technology we have, and whether or not you are looking at new emerging technology, and new commercial folks out there, that can provide us some hope that we can actually get this completed?

Admiral STEIDLE. Yes, sir. Yes, sir. We have, as I alluded to, we have done a lot of trade studies analysis. This is for the Crew Exploration Vehicle, not the Heavy Lift, which—we can segregate those two pieces into different avenues. But on the Crew Exploration Vehicle, there is a lot of commercial pieces that are available. The—we are looking from the Shuttle-derived variations, where we can take the reliability of pieces that have been used on the Shuttle, to what is being used on the EELVs today, and doing the trade studies on both of those pieces.

And that is the process that we are going through. You have to look at the life cycle costs of those particular systems, the logistics efforts of those, the infrastructure that is in place today, versus the development costs that are needed later on, and then, the human rating aspects of that, what it costs to actually put the Crew Exploration Vehicle on top of these particular pieces. That will be concluded in April, and then, Bill and I will work as—together to go forward to define those capabilities that are going to be required by the summertime for the teams that will actually build the demonstration, they need to have that information by the summer of '06.

There is assets—there are assets out there that will meet our needs. There are proposals from these 11 teams that we have been working with for the last year right now, to put the Crew Exploration Vehicle on top of it. So I feel very confident that we are going to move forward, and have a very good solution for it.

Mr. CALVERT. Thank you, Admiral. I see my time has expired.

Chairman BOEHLERT. The gentleman's time has expired. Ms. Jackson Lee.

Ms. JACKSON LEE. Thank you very much, Mr. Chairman, and to the full Committee Chairman and Ranking Member, to the Subcommittee Chairman and Ranking Member. I think this committee and the responsibility of oversight is, if you will, embracing of all philosophies. We know the importance of NASA. We know the importance of science, and so we come to the hearing with the concept of how we can do better.

And I thought I would just offer some observations that are somewhat painful, but I think it is important to couch our debate or our discussion in a very realistic perspective. First of all, the budget that we are operating under, the proposed Administration's budget, and the constraints that we have to work on here in Congress, I think, can be appropriately named the pinch and pain fed-

eral budget. It makes it very difficult for us to make the right kinds of choices, and it forces on us priorities that eliminate some very good options and opportunities.

I am concerned about that.

I also believe that NASA has gained, and I thank Ranking Member Gordon for his leadership in terms of the advocacy that he has shown as it relates to the NASA human Space Shuttle in particular, because I am reminded of more than 10 years ago, when it was a very, very tall mountain to climb in order to get across the board support from all regions of the country to support NASA.

Frankly, I believe it is important for us to develop stakeholders, more so than the reordering of an appropriations process to make friends. You don't make friends that way. You make friends by ensuring that the NASA program invests in many aspects of science, including human Space Shuttle, which I happen to be a very strong supporter of.

FUTURE OF NASA WORKFORCE

As I look at, if I may pose these questions dealing with employees and staffing, and I do so even in light of the fact that Kennedy and Johnson, Johnson in Texas, may have some protection only because we are dealing with the human Space Shuttle for the next couple of years, up to 2010. But I always am reminded of the fact that if they come for you at night, they will come for me in the morning. And so it is important to understand what we are doing with our employees.

I am particularly concerned that if we have these rumors about closing, one, you are losing outstanding research scientists. Two, all of your future scientists now being trained in our institutions around the Nation, our institutions of higher learning around the Nation, and possibly international scientists, have no reason to look toward NASA or look toward the science entities here in the United States, because we are cutting individuals. Of course, maybe your answer will be that you are cutting administrative, et cetera. But that is not what is going out across the wires. So I want that question again, and I know that it was probed earlier, but this seems like a BRAC. We have no understanding, we—is there a commission? What is your timetable, etc.?

My second question leads into my safety concern. The CEV vehicle that we are talking about, and I do want to acknowledge, mind my manners, thank Sean O'Keefe, the Administrator, for his great service, and I do want to say Administrator Gregory, which I will call you, your service is to be appreciated by this nation and by this committee. We thank you very much. But this vehicle that is proposed, there are proposals, but it is a draft request for proposal. It contains no requirement for the CEV to ferry crews to and from the International Space Station. One of the concerns I had with the Gehman report, and I couch it in terms of concerns, is that it didn't go far enough to review the safety needs of the International Space Station.

Over the months and years, we have heard of different deficiencies. Safety is a big issue. Safety is an issue for the astronauts. Safety is an issue for those who are at Kennedy and Johnson. Safety is an issue for the ISS, and I would like specifically to ask what

is the safety budget? Where is that line item for the next five years, and what is it for the last two years, so that we can compare? What is NASA's commitment to safety? So I ask you to share with me your ordering of this BRAC for NASA. How are we going to protect these employees or reinvest in our employees, so that we get the kind of talent we need, the CEV question, and of course, the safety question.

I thank you, Mr. Gregory, very much.

Mr. GREGORY. Thank you, ma'am. Very, very, very important questions.

Let me address the awareness, and I think you have rightfully pointed out an issue that we have really been working with. I think, if you would really look at what has occurred in the last year, we have always believed that if we make decisions at Headquarters, everybody knows exactly what it means, and there is no misinterpretation. What we found out was, in fact, that doesn't happen. And many times, decisions are made, and they are misinterpreted, and what we end up with are a series of rumors and people are very concerned about it, not only from their welfare, but the integrity of the programs that they are working on. We have taken a very active role in the last year to move to each center, and in fact, we have done that, with a group of folks, where we talk about those very specific areas and issues.

And we have also been—major—we have also encouraged the center directors to go back and tell, as they should, exactly what the plans are. Sometimes, we miss a person, or a group of people, and we then very quickly try to go back and describe exactly what the process is, how it works with the vision, and what the transformations that occur, and after we have been able to do that, we have had, I think, very good agreement and understanding by our people. But we really need to do more.

NASA BUDGET AND SAFETY

The second issue, on safety. You have at this table two people who actually flew in the Space Shuttle, myself and Bill Readdy. And so we are very aware of the issues that you are mentioning. There has been a major re-look at the safety program in the agency. It has also looked at the independent assessments. It has also looked at the way that the agency can determine whether choices or decisions or waivers that have been granted are, in fact, valid. And so this is a dialogue that we should we have where we fully explain all of the pieces and parts that not only responds to the Accident Investigation Board, but we believe go way beyond that.

Your question of budget, we have Steve Isakowitz, the Comptroller, on the end, and Steve, can you handle that?

Mr. ISAKOWITZ. Yes, sir. You asked a question on budget with regard to the safety.

Ms. JACKSON LEE. Sir.

Mr. ISAKOWITZ. Yeah. We actually don't have specific budgets just for safety. We have, in a number of areas, teams of folks that are dedicated, such as the NASA Engineering and Safety Center, that we had set up in this year's budget, which is about $70 million in the '06 request. We also had set up an independent technical authority, which was one of the recommendations that came out of

the CAIB, and there, we had identified about $80 million in the '06 budget for that purpose. But we also, in the dollars that we invest in the Shuttle and Station program, we have people as part of their job, safety is an important aspect for it. And so to that degree, we don't specifically break out those safety-related items, even though it is integral to the overall safety strategy.

Ms. JACKSON LEE. Thank you, Mr. Chairman. I see my time is up. May I just pose this question to the Chairman? I would really like them to provide me in writing those specific numbers on safety, and also, the answer regarding the number of employees they are projecting to be cutting from around those centers. And I would appreciate it very much. And I thank the Chairman for his indulgence.

Chairman BOEHLERT. Thank you very much, and all Members will be given the opportunity to submit questions in writing to our witnesses, and we will accumulate them, submit them to Mr. Gregory and his team, and ask for timely responses.

The Chair now recognizes Mr. Hall of Texas.

SPACE SHUTTLE AND CREW EXPLORATION VEHICLE SAFETY MODIFICATIONS

Mr. HALL. Thank you, Mr. Chairman. I think Ms. Jackson Lee hit on the thing that this country listens more for at this time in conjunction with the space program than anything else, and that is safety. And I would like more specific than we have been given.

I know it is difficult to design, because of weight problems, proper material, and designs, but two things that have kept us from having a safety escape mechanism of some type for these men and women, isn't design and difficulty, but design and cost. I can't accept the fact that you can put cost into that, because I don't think you can put a figure on the lives of the people that have—we have already lost, and all of you know that two years ago, the *Columbia* disaster underscored, I think, the sad reality that we have not done enough to ensure crew safety.

I think you remember, or are aware of the fact, and I am sure the Comptroller is, that I authorized an amendment that was included in last year's NASA funding bill, that calls for $15 million to be used to solicit the best concepts from the aerospace industry and elsewhere to improve Shuttle crew survivability. You are aware of that, are you not?

And I will go ahead and ask the second question. What safety changes have you made for the first future flight, which I understand the window opens about May the 12th for this year?

Mr. GREGORY. Mr. Hall, why don't I let Mr. Readdy answer that question, but let me tell you something. Safety permeates NASA. We have values, NASA values, number one is safety. Number two is the NASA family. Number three is excellence. Number four is integrity. When you go to different centers, you talk to different people, they don't have a variation of that. That is—those are the NASA values that we have, that we work to every day. Bill Readdy has been on top of the—of all of the safety enhancements, and I think—Bill, can you, why don't you summarize some of those for Mr. Hall?

Mr. READDY. Mr. Hall, thank you for your support. Crew escape is, I think, what you are talking about, and as you mentioned, the inherent design of the Space Shuttle really makes it nigh on impossible to put that into the Space Shuttle design. That was one of the things that influenced our thinking on making sure that we would only fly those flights necessary through the end of the decade to complete the International Space Station. And not fly to 2020, as had been previously planned.

Admiral Steidle and his folks are ensuring that in the request for proposals for the Crew Exploration Vehicle, that we build in crew escape throughout all modes of that vehicle. And I think that represents the real commitment that we have in the future to providing a safer means of getting crew to and from space.

Very specifically, though, in the Space Shuttle world, as we all know, the foam liberated off the tank caused the accident. But we haven't simply looked at insulation of that external tank as what we must do to Return-to-Flight. Today, we are testing solid rocket motors out in Utah. Today, the Stafford-Covey task group is down in Florida reviewing our progress on Return-to-Flight implementation plan. We are looking across the Space Shuttle hardware, from stem to stern, including all the ground operations that we do, and the management operations, in order to make sure that we come back not only much smarter as a result of the *Columbia* accident investigation, but also with a much stronger and safer program.

Mr. HALL. I certainly don't question anybody's interest in safety, nor would I even dare to question those of you who have undergone the vicissitudes of flight, and the dangers, and know better than any of us here the—really the fragility of that flight in the future, and that one that we are going to launch later this year, and those that follow.

What I want to know is, and I understand the difficulty involved in attaching or installing an escape module in any of the three existing Shuttles, but I don't really want to see us initiate any new thrusts unless we are at least underway with incorporating safety mechanisms and devices. I won't say modules, because you may have a module, and you can't put a module in a module, but I use the words safety mechanisms and devices. I think that is what this country and this committee and this Congress, and this—and everyone interested in the space thrust is listening for, is safety that you are underway with now. I would hate to have another tragedy, and not have us underway with trying to solve the problems that exist with the losses that we have had.

So I guess what I really would like to know is the $15 million, how that has been spent, and has it been spent, and is it allocated still toward that that it was set up for?

Mr. GREGORY. Admiral.

Admiral STEIDLE. Sir, we will have to get you the specifics on exactly where the $15 million went. I can tell you, as Bill said, our top priority in the Crew Exploration Vehicle is safe escape throughout the entire envelope, and that is through mechanisms, modularization, and designed by industry with us. But as——

Mr. HALL. What does that mean?

Admiral STEIDLE. That means working with industry, we have established the capabilities, and we have stated that you—industry

and the design team has to have the capabilities for a safe crew ejection and safe return throughout the entire envelope. You may miss—we may lose a mission, but we will not lose the crew. That is the design specifications. Now, how you do that has to be done together with us and industry together in that. Specifically, where that particular funding went, I will have to get back to you, because I don't have that with me, sir.

SPACE SHUTTLE RETURN-TO-FLIGHT SAFETY MODIFICATIONS

Mr. HALL. All right. All right. And the last thing I want to ask, I think there was a question asked about the basic changes in the—for the first launch. Was that your question, Mr. Chairman? And the number of crew members, and I didn't hear an answer to the number of crew members.

Mr. READDY. With respect to Return-to-Flight.

Mr. HALL. Yes.

Mr. READDY. We have looked at those things that we must accomplish on that mission, and as you know, the first two flights are going to be test flights. There are so many things that we have done to improve the system, that even given the exotic laboratories that we have here on Earth, the vacuum chambers, the wind tunnels, the computational fluid dynamics, and everything else, quite simply, we won't know until we actually go fly. So the first two missions are test missions. They include a whole number of safety changes, not only the ability to observe the Space Shuttle during its ascent, all the way through the external tank separation, the ability to inspect the vehicle with an orbiter boom sensing system, and then, when we get to the Space Station, we will also be doing developmental test objectives to look at reinforced carbon carbon, or the wing leading edge material repair, as well as tile repair. All of those things require seven people on Return-to-Flight missions, sir.

Mr. HALL. So seven is the figure.

Mr. READDY. Seven is the figure for the Space Shuttle Return-to-Flight.

Mr. HALL. I thank you. I yield back my time.

Chairman BOEHLERT. Thank you very much. And that return-to-flight will be commanded by Colonel Collins?

Mr. READDY. Yes, sir. That is correct. Colonel Eileen Collins, sir.

Chairman BOEHLERT. A New Yorker, I might add. The Chair recognizes Mr. Udall.

Mr. GREGORY. Not only Elmira, but also Air Force——

Chairman BOEHLERT. And also a Syracuse University graduate.

Mr. GREGORY.—instructor at the Air Force Academy.

Chairman BOEHLERT. Mr. Udall.

POSSIBILITIES FOR A SHUTTLE SERVICING MISSION TO HUBBLE

Mr. UDALL. Thank you, Mr. Chairman. I will attempt to follow in the footsteps of my good friend, Mr. Hall, in his loquacious brevity. The Hubble Telescope, of course, has been the center of a lot of discussion recently. I want to focus my initial comments on the

telescope. And I have made no bones about my support for a servicing mission, and I am afraid the treatment of Hubble in your testimony doesn't really address my objections to the Administration decision to terminate funding for any Hubble servicing mission.

I know you have to support the Administration's position on Hubble, so I don't expect you to change your testimony, but I would like to review the bidding. NASA asked the National Academies to review the options for extending the useful life of Hubble. A distinguished Committee did that, and their conclusion was unanimous and unambiguous, and that was that a Shuttle servicing mission is the best option for extending the life of Hubble, and for preparing it for eventual robotic de-orbit. They also concluded that a robotic servicing mission was unlikely to succeed in the time available. In the wake of that report, what did NASA do? Well, NASA eliminated the funding for the robotic servicing mission, but it didn't reinstate the SM–4 servicing mission, and I think I am not alone when I say I don't understand that.

The Academies Committee squarely addressed the issue of safety risk, and concluded it was comparable to flying the Shuttle to the Station, which NASA is already committed to doing. And I haven't heard any convincing rebuttal from NASA to the Academies safety risk assessment since their report was issued late last year.

So in that context, let us look at the remaining issue of cost. Your accomplished panel, Mr. Gregory, told the Chairman that it would be about 28 flights give or take what will be needed to complete the International Space Station, but you also said this number isn't solid, and could likely change, so it appears to me that the potential impact of an extra Shuttle flight to service Hubble is overwhelmed by the uncertainty in the estimates of how many more times we will be flying the Shuttle before it is retired.

Isn't that so?

Mr. GREGORY. Administrator O'Keefe made a very conscious and deliberate and well-informed decision that the Shuttle would not service the Hubble. We acknowledge and recognize and agree with the Academy, when it says that the Hubble is a wonderful vehicle, has provided excellent information. We have learned quite a lot from it.

Mr. UDALL. Mr. Gregory——

Mr. GREGORY. But I can tell you that I agree with Mr. O'Keefe, as a former Shuttle pilot, and so I have the—at least the credentials to talk to you about what it is that I would consider safe or risky, and I will make that very strong recommendation to the next Administrator, who—either he or she is.

Mr. UDALL. No, I am not questioning your service and your valor. What I wanted to make the point is, is that in the context of 28 or 30 additional flights, because I am talking about cost now, not the safety side, of the equation is that an additional flight fit into that timeframe to me, doesn't seem to be something that is—would overwhelm what we are trying to do with the Space Station.

So if I can continue, just—my commentary. The National Academies, when Dr. Lanzerotti spoke before us two weeks ago, he made a very important point. He said that when deciding whether to allocate the costs of a Shuttle servicing mission to the agency's science program, it is important to remember that throughout the

life of the Hubble program, the costs of Shuttle missions to service Hubble have never been charged to the science program, and the costs of Shuttle missions to the ISS have never been charged to the Station program. I believe those statements are both true.

Mr. GREGORY. Now, those were true, and they were certainly applicable before the *Columbia* accident.

Mr. UDALL. And so in that context, do you see any logical basis for changing the commitment that Administrator O'Keefe made to Congress, namely, that the Shuttle costs of SM–4, Shuttle servicing mission, would not be charged to the science program? This statement from—answer to a question from Administrator O'Keefe was in response to Mr. Gordon asking him about the Hubble servicing mission, and it was in this statement, which I would like to enter into the record, Mr. Chairman.

Chairman BOEHLERT. No objection.

[The statement follows:]

STATEMENT OF MR. SEAN O'KEEFE

Below is the answer submitted by Mr. Sean O'Keefe, Administrator, National Aeronautics and Space Administration (NASA) in response to written questions submitted by Congressman Bart Gordon resulting from the February 27, 2002 Science Committee hearing on NASA's FY03 budget request:

Q2. According to the FY 2003 NASA budget request, the new policy is that the cost of any Shuttle flight above the four per year allocated to the Space Station will be borne by the customer for that flight. In your response to my question at the February 27th hearing, you stated that "in the next Hubble servicing mission two years out, you will see that cost incorporated in the space science costs." Does the five-year budget runout for space science contained in the FY 2003 budget request include funds for the cost of the Shuttle flight for the next Hubble servicing mission? If so, how much funding is allocated for that Shuttle mission, and where is it included in the space science budget, by account and fiscal year?

A2. The next Hubble servicing mission is SM–4, which is scheduled to launch in 2004. This long-planned servicing mission is considered "grandfathered in" under this policy, and the projected budget for the mission was included in the five-year budget run-out under the Office of Space Flight. The Office of Space Science will have to budget for the Hubble retrieval mission, currently scheduled for the 2010 timeframe.

Mr. UDALL. The servicing mission was considered grandfathered in under this policy. So the point I am trying to make is that I don't think cost is the concern here, and I would like your comments.

Mr. GREGORY. Thank you very much, Mr. Udall. Exactly right. Cost is not an issue, as we evaluated whether—if there were extra flights or so one of them could go to the Hubble. That was not an issue at all. What we have done is to look at what we have done in the past, and then, the—I think the Accident Investigation Board was really an eye-opener, and there is a paragraph in the Accident Investigation Board report that I would like to enter into the record, that really says you know, you guys have just become so can do that sometimes, you forget that this is an extremely risky business, and we tend to minimize what is sane to do and what is inappropriate.

As I looked at it from the commander's point of view, and I have had that privilege several times, I began to look at what are those things that we would have to do to assure the absolute safety of the crew, and then I began to look at the options that we had. One

of those that they mentioned in the Accident Investigation Board was a safe haven.

A safe haven is a place where you can go without an issue of whether you will sustain your life or not, and have the ability to sit and think, not only on-board, but also, the people on the ground. If you go to the Space Station, you have that opportunity. You have a very large, as Mr. Readdy talked about, a volume in there, and you can put all of the crew in there to sit and think.

When you go to the Hubble, you don't have that opportunity at all. The only life support activities, or the capabilities you have are those things that are resident on the Shuttle. And I know the Academy talked about 30 days. Well, let me tell you, that is not a good date. That is something that says you have powered down the orbiter to a point where you are maintaining the ability to power up and come home. But it really doesn't address the issue of what the quality of life is on board, or whether, in fact, it can sustain life. We do not have a Transatlantic abort site for a 28 degree launch. Now, let me tell you what that means. When you launch, you always want to have an opportunity to land, and if you lose a system or an engine, you would like to be able to proceed straight ahead and land at a prepared site. We do not have any sites for 28 degrees, which is a due east launch out of Kennedy.

The next thing is, we would have to hold a vehicle on the ground, and that sounds simple, but to have a vehicle standing by to get to the orbiter, that is—has a problem, within 15 days or less. The agency has never demonstrated that capability before. So this is a very high risk activity. And let us assume that we had it. We will have never, ever practiced a rendezvous of two orbiters on orbit, and this sounds simple, again, but I can tell you, and Bill Readdy can tell you, this is something no one has ever done before. Probably, we could do it. Probably, I don't know how that means. I don't know what that really means. But it also means that we are going to have to rendezvous and get into an attitude, and connect these two orbiters. We have never done that before. And so we have a significant number of risks that I think that the Academy may have brushed over. And of course, the first one is that we haven't launched it yet, and that is not occurring until May, and so there were some assumptions—and there are many, many other areas that we have looked at——

INTERNATIONAL SPACE STATION SAFE HAVEN CAPABILITY

Mr. UDALL. I see my time has expired. But I think if the Chairman will indulge me for a minute. I think this is an important line of discussion. I understand what you are saying, Mr. Gregory, but I also know that—at least, I am under the impression that NASA is not planning for a safe haven on the Space Station after the first two Shuttle return-to-flight flights. And the question then becomes how long are you going to baseline safe havens, if it is not going to be continued, then essentially, there is no difference between the ISS and the Hubble Telescope missions, and many in the astronaut corps have pointed that out, as the NAS study did as well.

And I respect you defending the position that NASA has taken, but I do think that when you look at the relative dangers involved, and the risks involved in these two types of mission, that there is

not a lot of difference between. And I know that there will be many of us who will continue to advocate that if we are unwilling to take the risks to go to Hubble, then what does that say about a Moon and eventual Mars mission, that there are risks in space travel and exploration, as my good friend Congressman Hall pointed out, but there are also ways to balance those risks with the rewards, and Hubble is such a tremendous asset, both public relations-wise, as well as the science that has been developed, that there are many of us that continue to believe there has to be a way here.

I made a speech on top of my questions, and I apologize, but if you could briefly answer my questions about the baseline safe haven concept that you are pursuing.

Mr. GREGORY. Well, let me give you an initial one sentence, and then pass it over to Bill Readdy. A safe haven is always an opportunity on the International Space Station. It will always be there, and whenever we dock, whether we have planned to have it as a safe haven or not, it will always be there. It will always be there as a contingency, even though we have not planned to use it as a safe haven.

Bill.

Mr. READDY. To provide a little bit more detail, you are exactly right. For the first two flights, we have insisted that we have a safe haven available onboard the International Space Station, and we are going to assess exactly how many days we have. As Mr. Gregory mentioned, what the Space Station offers is the ability to very deliberately assess the situation before you commit to launching another orbiter.

We could certainly have another orbiter stacked, ready to go on another launch pad, but to commit to flying that orbiter to do a rescue mission, to do the high wire act that he talked about, a free space transfer of crew members, suited, from one ship to another, to commit to that ahead of time we don't think is a prudent thing to do, and we respectfully disagree with the National Academies assessment of that as trivial. *De minimis,* I think, was the term that they used.

In terms of Space Station having a safe haven capability, on the 28th of this month, when the Progress launches, we will have an ability to assess what the safe haven capability is. Just for planning purposes, we have been looking at 33 days. That includes a number of engineering analyses that we have done, and counts on having failures as soon as you launch the Space Shuttle, of the oxygen generating equipment on board the Space Station. When the Progress docks, we think planned right now for March 2, we will have a much better assessment, and we would expect that the number of safe haven days aboard International Space Station would be 40 plus days at least. Some estimates are in the 50s of days. That certainly gives you an awful lot of time to very soberly, very deliberately assess the commit to launch of a rescue mission.

And finally, with the Space Station, you can effect a shirtsleeve transfer just as part of our nominal operations, which we do routinely, with the Space Shuttle docked to International Space Station. So I think all of those things are not trivialities, as were kind of stated by the National Academies.

Chairman BOEHLERT. Thank you very much.

Mr. UDALL. I thank the Chairman for his indulgence. I think this is a very important issue, and this discussion has been very helpful.

Chairman BOEHLERT. I agree on both counts. Dr. Ehlers.

RISK ASSESSMENT AND SAFETY

Mr. EHLERS. Thank you, Mr. Chairman. I had planned to ask the same questions. So I will simply continue the line of questioning.

The Hubble Telescope has been described as the greatest advance in astronomy since Galileo developed the first telescope, and I think that is probably accurate.

The Hubble Telescope, in a week, would probably do better and more science than we are likely to do during the lifetime of the Space Station. I have yet to see any good description of any important, meaningful scientific research that we are planning to up there, and I would be—I would love to be shown wrong on that. But the Hubble is a real treasure. I believe Mr. O'Keefe's decision was wrong. I told him that the day after he made it. And what I see before me now appears to me very much to be simply trying to justify a decision that I believe was made in haste, and was not an appropriate decision.

When you talk about the cost as being $2 billion, that is certainly an inflated figure, when you are able to fly, you are talking about five flights for $4 billion, why is it $2 billion for the Hubble flight? And Mr. Gregory, I have to respond to your question about absolute safety. If you are going to insist on absolute safety, you are not going to fly again, and you are definitely not going to send anyone to Mars. Get rid of the term absolute safety. There is no such thing.

There is risk involved in going into space. Every one of your astronauts understands that. I have talked to them personally. I have asked a number of astronauts personally, would you be willing to volunteer to go on a Hubble mission if you were given the opportunity. None of them I have talked to have said no.

The—I believe the commission that studied the *Columbia* disaster did an excellent job, but I am concerned about the lack of understanding of risk analysis among the public and many people involved with this. You cannot guarantee absolute safety. You try to reduce the risk as much as possible, but all of you—those of you who have been in space, those of you involved with this, recognize there is risk associated with it. There is also risk associated with me driving my car from my apartment to work, and a sizable risk, and yet, I do it every day.

We live in a sea of risk, and we try to minimize the risk, and I appreciate what you are trying to do, but I think—I am really concerned, not just about the Hubble, but about the impact on NASA itself if we get so overwhelmed with concerns about safety and not—aren't willing to recognize that there is a risk, and set tolerable risk limits, so that you can accomplish your missions. Otherwise, as I say, we are never going to go to Mars, if we continue to insist on such low levels of risk. The costs will balloon out of sight, and the country will not be willing to pay for it.

I—your analysis—I can understand why your analysis of risk might differ from the NRC's. At the same time, these are pretty

bright people, and they understand this issue. You said in your testimony, the mission was canceled based on analysis of relative risk. I would like to see that analysis, if you would provide that to us, and see what detail you went into, and in what ways you differ from the National Academy of Sciences. I would very much like to see you change your position, and dedicate a flight to saving the Hubble. I believe the scientific merit of it deserves that chance, and the risk is no greater than any of the more than 100 missions you have already flown, and I think although the disasters you have had are horrible, you have lost two flights out of roughly 100, and that is greater than the risk you had anticipated when you began flying the Shuttle. But it is—I don't want to even say it is an acceptable risk, but I think you have got a pretty good record, and I don't think you should be ashamed of that. You have shown that the Shuttle is a safe vehicle. Both of these disasters can be explained by anomalies that were not foreseen, and—which is what most accidents are caused by. And you should not be ashamed of your safety record. I think it is good. I think you have really done a good job, and you have tried hard. And I don't see that much of a risk in going to the Hubble again, which you have already done a couple of times, and I would love to see it happen.

I appreciate any comments you are willing to make in that regard. But if you are talking about 28 flights up to the Space Station, certainly one flight to Hubble is of lower risk than 28 flights to the Space Station. You are much less likely to suffer a catastrophe on one flight to the Hubble than you are in the 28 to the Space Station. And I think you have to look at the relative value of those.

Mr. GREGORY. Dr. Ehlers, let us talk the science part of the relative value of the Hubble, how it works with the Chandra, with the Spitzer, with the Swift, with the James Webb that is coming up. Al Diaz would be the appropriate one to respond to the science aspect.

Mr. EHLERS. Okay.

HUBBLE AND THE FUTURE OF NASA ASTRONOMY

Mr. DIAZ. Well, I appreciate the opportunity to say a few words here, because both Mr. Ehlers and Mr. Udall, I think, with their comments, really have confirmed that the work that we have done on Hubble has produced exactly what we intended to, which was world class astronomy for the past 15 years. And having been there in 1990, when Hubble was launched, and having been involved in the development of it, I am humbled by the fact that it was really the Space Shuttle and the Space Shuttle crews that made the difference between Hubble becoming space junk and it being exactly as the Academy identified it, as the greatest advance since Galileo.

It has been difficult for the team to accept at times that—the nature of the decision that was made, but frankly, I think all of us have accepted the fact that in the wake of the *Columbia* accident, that it is impossible for the Agency to commit to doing another mission. In fact, as the director of the Goddard Space Flight Center last year, I was the one that proposed to the Administrator that we look at the robotic servicing of Hubble, which actually led to the Academy evaluation, and I must say that, in the end, while I might

not agree with every one of the recommendations that the Academy has made, their final conclusion, actually, with respect to the robotics, is consistent with four or five other independent reviews, that being that the cost would be very high, and the $2 billion number that you mentioned, that is associated with that robotic mission.

What we have been forced to conclude is that the discussion about Hubble really needs to be a discussion about continuing that world class astronomy program, and not about the telescope. And I think that—I would suggest to you that the budget that we have brought forward, and the strategy that it supports, is one that is focused on continuing that world class astronomy program. It clearly recognizes the need to continue the Hubble Telescope activities as long as possible. We believe that that could extend into 2008, at least now, and hopefully, we will be able to manage some developments that might get it to 2009. The other part of our strategy is to keep the development of the successor, or the follow-on telescopes, for the astronomy program, on their current schedules by investing in maintaining those schedules, specifically with regard to that—the James Webb Space Telescope, which promises to continue every bit of the discovery space that Hubble has.

In addition to that, we intend to continue to support the development of other capabilities that might extend the telescope's life and continue the support of the archive data. I think it is probably not well-known, but 40 percent of the discoveries that are reported out of Hubble are actually extracted from the archives that are at the Space Telescope Science Institute. And so I think that we have come forward with a plan in the 2006 budget that is, in fact, one that promises to continue the world class astronomy program, despite the fact that we will no longer plan to service the telescope.

Mr. EHLERS. In the appropriations last year, Congress directed NASA to spend $291 million on a Hubble servicing mission. What is happening to that money?

Mr. GREGORY. Craig, do you want to—Steve?

Mr. ISAKOWITZ. Sir, I will be happy to take that one. Congress did identify $291 million for the purposes of robotic servicing. In our first operating plan letter that we sent to the Congress that laid out our plans for fiscal year 2005, we had identified $175 million specifically so we can do some of this early design work, looking at the servicing, and now focused on a de-orbit mission that we think will take us through the March/April timeframe. Our current plan now is to assess where we are at that time, and determine what additional resources are needed in this fiscal year to take us through, and so our plan is in our—as early as our next operating plan, which could be at the end of February, early March, to indicate to the Congress our plans for how to go forward through the rest of this fiscal year.

Chairman BOEHLERT. I thank the gentleman for his line of questioning.

Mr. EHLERS. Let me just make a final comment. I don't think it makes sense to try to use robotics to continue the Hubble. The costs and the likelihood of success, I think, are too small.

Chairman BOEHLERT. Well, the timing, too, is also a factor.

Mr. EHLERS. Right. But I—yes, but I do strongly support a manned or womanned mission to continue the Hubble. I think you

get a lot of good out of it for a fairly small investment. I am fully aware of the other advanced telescopes that are going up, but there is a gap between—there will be a large gap between the Hubble, end of the Hubble, and the beginning of the James Webb at this point, and I would like to see that gap filled.

I am just concerned, as I said, that the decision was made—I don't think it was made on a sound basis, and now, I have seen NASA ever since then try to defend that decision, and come up with arguments of why that decision was right, rather than really going back and honestly re-examining whether or not it was right. And I would certainly appreciate an honest re-examination of that. With 28 flights going up, as Mr. Udall said, it seems you could spare one for the Hubble, and I don't think that the risks are going to be very much, if any greater, than any of the other 28 flights.

Thank you, Mr. Chairman.

Chairman BOEHLERT. I thank the gentleman, and I want to reinforce his request, Mr. Gregory. The Committee would formally request that you share with us the risk report.

Mr. GREGORY. Yes, sir.

Chairman BOEHLERT. Thank you very much. The Chair recognizes Mr. Honda.

CENTER TRANSFORMATION AND THE NASA WORKFORCE

Mr. HONDA. Thank you very much, Mr. Chair, and welcome, Administrator Gregory. Well, all this line of question has been very interesting for me, because this is probably one of the first times that we really had some detailed discussions, but I am still not clear on a lot of areas. When I first visited NASA Ames through—facility in Mountain View, some of the comments I heard while walking around there was this terminology called, what is it, full cost accounting and its impact on the way our skills and our folks are being distributed or redistributed, and then, I am reading about this term transformation.

I guess my question is, I would like to understand how you see the impact of transformation on existing contracts, including the research contracts and cooperative agreements, especially the kinds that we have had developed at NASA Ames in Mountain View with UC–Santa Cruz, or San Jose State, with Carnegie Mellon, and those others. Will NASA be fully honoring its existing obligations, and you know, and the reason I am asking is because I am concerned about the dissolution of that collaboration, relative to its impact on the kinds of science that we need to see, and relative to the kind of education I want to see happen from that point down into the public schools. And it just—I am not quite sure what all the details of your plan is to achieve your vision, and it seems to me that everything seems to be served, in my mind, disconnected or haphazard.

And then, I have one more other question, that I will ask, so that I won't get stopped by the red light. In looking at the vision and the mission of sending—going back to the Moon and to Mars, and it has been about two years now, since we have had this activity in front of us, has anybody done a plan, if you will, that would map out, in a backward fashion, from achievement of the goal, working it backwards and figuring out what the steps are, and developed

a PERT chart, program review evaluation technique, that they have used in the development of the nuclear submarine, which turned out to be a very good technique for moving a complex project such as this. Do you have that? Is that something that we can visit or see, or be shared with Members here, so that the complexity of the project can sort of be grasped by our minds, because right now, there are so many parts of it, it appears to be—there is costs, and there is personnel attached to it, and changing of techniques that—it seems to be very disorienting, I think, for a lot of people. And that is my questions.

Mr. GREGORY. Thank you, Mr. Honda. I think it would appropriate to have Al Diaz respond to the activities at Ames, and then, we will have Craig Steidle address the second portion of your question.

Mr. DIAZ. First, let me say that in my visits to Ames recently, I have recognized that the center has transformed itself dramatically over the course of the past five years of so when I previously visited. It is a new addition to the science family, and the center director and I have been having almost daily, if—well, weekly, anyhow, interactions about the transformation that is ongoing.

It—with regard to the agreements, I must say that I have not reviewed all of the agreements. Although the Center Director has not indicated to me that there are any agreements that are in jeopardy because of the current transformation, or full cost accounting. What I would like to do is take the opportunity of your question to review that with him, and get back to you with a full report.

NASA FULL COST ACCOUNTING

Mr. HONDA. Just a real quick question. In that full cost accounting, how does that allow NASA to attain its vision, say, in terms of the arena of nanoscale activities, which to me seems to be very essential in developing materials for space flight and things like that, so you have a lighter vehicle, but stronger, and capable of probably lifting greater payloads. So it seems like we are cutting out certain arenas that will affect future needs.

Mr. DIAZ. Well, I may not be the right one to talk about full cost accounting in general, and so if there is any further comment, that might be appropriate to Steve Isakowitz. But I do come from a center that does a fair amount of research at the Goddard Space Flight Center, and I have been associated with work that has been done at JPL. Fundamentally, there is no inconsistency between full cost accounting and research type activities. The issue is making sure that we understand exactly what the cost is that is associated with all of those activities, including the workforce cost. Typically, that has been the cost that—the cost of the workforce, and the cost of overhead, that hasn't been properly accounted for. I think that the transition to full cost has created some, if you will, some new understanding of how high the cost actually is that is associated with doing some of our research, when it is compared to other organizations that already do full cost accounting, like JPL or external organizations.

And maybe Steve would want to comment on it.

Mr. HONDA. But not being argumentative, it appears that in that full cost accounting, that you are forcing through budgetary ac-

tions, some elimination of necessary skills within our organization. Even though there may be other organizations that operate under full cost accounting, they are more of a privatized organization versus NASA, which is more government-run, and more research-oriented, where you do a lot of research, and you know, that may come up with some outcomes that would be necessary for space flight. It is just—it just is an observation.

Mr. DIAZ. I understand what you are saying, and I think we are trying to be careful about that, but let me turn it over to Steve at this point.

Mr. ISAKOWITZ. I think Al Diaz had it exactly right. Full cost accounting is an accounting tool. It provides to managers the insight on the full cost of what it takes to accomplish their specific program and project goals. With that information, managers are then in a position to determine whether or not it makes sense to continue to make the investments inside the Agency or another. But in and of itself, full cost doesn't force us to take any specific action. It does, for the first time, though, give us the insight as to what the cost is for the skills we need and the facilities we need in order to execute our programs.

Chairman BOEHLERT. Thank you very much. The gentleman's time has expired.

Mr. HONDA. Just very quickly, Mr. Chairman. I would like to sit down with you, and continue the debate, because you can have a budget-driven organization and miss your target, because you are on budget, and—but you are not going to be on target as far as your mission is concerned.

Chairman BOEHLERT. The gentleman's time has expired. There has been considerable discussion this morning about risk, and as we all know, there is risk in everything, including being in this room for a prolonged period of time. It is more conducive to a discussion of our polar program. In any event, nothing is ever simple in Congress. We don't have control over the thermostat. We have checked with higher authorities, and have been advised by the Superintendent of Buildings that someone will be dispatched to turn up the thermostat, and they will probably arrive just as we adjourn, so if you can bear with us a few more minutes, I would appreciate it.

Mr. Costa.

NASA PRIORITIES AND ROADMAPPING

Mr. COSTA. I will make one statement, though. Sir, you have already turned up the heat, and so I don't think anyone at this table is chilly.

I am sorry, sir. Thank you very much, Mr. Chairman. I am new to the Committee, and hopefully, we will keep the temperature just about right.

But in listening carefully to the questions that have been asked this morning, it seems to me what we really haven't come to the heart to, is what do we really want to make the basic mission of NASA for the next five or ten year period, notwithstanding the pronouncements of the President's with regards to the Moon exploration and Mars, it just seems to me that trying to get a handle, and a consistent, clear view on our manned space program and all

that that entails, versus our other efforts with our exploratory astronomy, that we have yet to reach a consensus as to just exactly what NASA's mission needs to be over the course of the next ten years.

I mean, the budget is what the budget is, and you know, it will vary, based upon our other priorities, but once we have made a decision on that, you have got a set amount of dollars to deal with, and it seems to me the underpinning of the basic hard question that we seem to discuss around, and I am supportive of the Hubble effort as well, but we need to complete the Space Station, I think. And the problem, it seems to me, is we basically haven't decided what the primary mission or missions of NASA is going to be over the course of the next ten years. And notwithstanding a lot of—what a lot of people's agenda or ideas are—and so I guess I would like you to maybe try to indicate to us in terms of what steps you are taking to attempt to prioritize, notwithstanding your funding, where you think the manned program fits with the other priorities that are there.

I mean, it just seems like a whole lot of things that have been thrown against the wall at this point in time, and we are all very proud of NASA and the accomplishments that you have achieved over the decades, and obviously want to see that continue, but without a clear and concise consensus, I am not so sure that we are going to make much progress.

Mr. GREGORY. Thank you. Thank you, sir, that was an excellent question, and it is an area that we have not touched on. It is certainly one that we really need to inform all of us about.

A while ago, in pursuit of the answer, we—the senior leaders decided that what we needed to do would be to develop roadmaps, and we—in fact, we have 13 of those. And each of the roadmap teams has a person from outside of NASA, from academia, or industry. We have a center director, in general, and we also have several of the members of this table as co-chairs, on each of these roadmaps. And each of them is looking at the future to determine what the future should be, and then, there is an—or a goal, as the agency moves forward.

And then, there is an activity where we integrate all of these together, to come out with a single or several absolute goals that the agency would be holding our feet to the fire on. That is an activity, also, in work. And it is one of many activities in the agency that we have to make—decisions that we have to make that, again, gives us not 10 years, but probably 30 or 50 years in the future, to talk about how the agency, this great agency of NASA, provides a significant value to the population, not of the United States—not only of the United States, but of the world. And it is an activity, it is an ongoing activity. We have short-term goals and short-term goals take us out to 2020, 2030. It follows on the question that Mr. Honda just asked, about the goals in the future, and how you work—how you come back from that to determine what we do on the Space Station, what we have to learn from the Earth, what we will learn from the Moon, as we progress to Mars.

And if you would, sir, the person who is responsible for that in the agency is Craig Steidle, and if it is okay, I will ask him to give you some further comments.

Mr. COSTA. I would specifically like to know what timeline you are focused on, in terms of internally making these recommendations to the Committee and to the Congress, as to where you think the priorities of NASA should be in the next 30 years, using your timeline.

Admiral STEIDLE. Yes, sir. We formed the 13 roadmaps, as Mr. Gregory pointed out, such as robotic and human exploration of the lunar surface, robotic and human exploration of Mars, transportation systems, launch systems, in space systems, and then we are going to integrate those particular roadmaps. We—each one of those teams have been formulated. They are FACA, so they are open to the public. We have had a meeting of each one of the roadmaps, the last one being the nuclear roadmap, which I chair as well, yesterday. We will have a second meeting of those, and try and complete those, by the middle of April. And then we will integrate those, and take them this summer to the National Academy for review.

And that should set, in very, very high terms, our strategic direction for the future. And that is—those are going to be living documents which will be reviewed on a reoccurring basis. That will also translate to technology investments and requirements below those strategies, to support those in the future, which will lead to our investment strategies and our budgets of the future. So to answer your question, they are coming together, the first blush will be completed in the second in the second meetings, by around April, mid-April timeframe, and then to the National Academy as soon as we can get it scheduled, early summer.

Mr. COSTA. Thank you very much, Mr. Chairman.

FUTURE OF THE INTERNATIONAL SPACE STATION WITHOUT THE SPACE SHUTTLE

Chairman BOEHLERT. Mr. Gregory, I want to commend you for the skillful manner you handled the newest Member of our committee. That is an excellent question you asked.

I have got a few brief questions here that don't require long answers, and I would like to ask them now. Does NASA have a backup plan for constructing the Space Station, if the Shuttle cannot remain in service?

Mr. GREGORY. And—you are referencing some time between now and 2010, if we lose the——

Chairman BOEHLERT. Right.

Mr. GREGORY.—capability.

Chairman BOEHLERT. That is correct.

Mr. GREGORY. This is a—certainly a question that Bill Readdy would, and can answer. I can tell you, though, that the resiliency of the Agency and the industry that supports the Agency would answer, if we lose another Shuttle, that we would still be able to complete the International Space Station, with the two remaining. Each time we have lost a Shuttle—each time we have preceded the lost of a Shuttle, we had told ourselves that if we lose another one, we can never proceed, or we can't proceed. But in each case, we have. Now, we have come out a stronger Agency each time. But Bill, let me pass that to you, and see what your response would be.

Mr. READDY. Well, Mr. Chairman, I—if your question is the unique capabilities of the Shuttle, not only to take these modules, and provide the right launch environment for them, haul the cargo, the crew, be the base for the robotics operation with the robot arm, and conduct assembly spacewalks, really, there is no alternative to that. In testimony before the Senate here some months ago, the same question was raised, and our estimate are that in order to provide an alternative launch capability, we are talking about on the order of $1 billion to repackage those elements to launch in another capacity, and that doesn't include replicating the robotics capability, or hosting the spacewalks required.

Chairman BOEHLERT. All right. Let me ask you then, do you have a backup plan for servicing the Space Station if changes are not made to the INA?

Mr. READDY. Well, clearly, we have worked together as a partnership, and the strength of the partnership, I think, is something that we are all extremely proud of, over these last four years, or these last two years since the accident, and we are now entering our fifth year of permanent presence on board the International Space Station. Clearly, we didn't anticipate losing the Shuttle. We didn't anticipate having to rely exclusively on the Progress resupply vehicle, and that has stretched our logistic supply line very thin. Fortunately, the Ariane 5 launched successfully on Saturday, this past Saturday. That is the launcher for the Autonomous Transfer Vehicle that the Europeans are providing. That will provide us an additional leg of redundancy, and resilience in our ability to resupply the Space Station. The Japanese HTV, their launch vehicle right now is planned for Return-to-Flight here on the 24th of this month, and so we have several legs of redundancy, in terms of being able to provide resupply for the International Space Station. And then finally, what we intend to issue, in terms of a request for proposal this summer, and complete a contract by the end of this calendar year, is commercial ISS crew and cargo services, which would, of course, be open to our industry.

COST ESTIMATES FOR THE DEVELOPMENT OF THE CREW EXPLORATION VEHICLE

Chairman BOEHLERT. Last year, NASA set its rough estimate for the total cost of developing the CEV was $15 billion. Is that still a good number?

Admiral STEIDLE. Yes, sir. It is in the realm of putting the Crew Exploration Vehicle forward and with the demonstrations in 14, and the crewed version of that 15 to 16 is what we have been logging in our books, sir.

Chairman BOEHLERT. And when would you think would be a good time for Congress to assess the progress in building the CEV, so we could pull the plug if, and I hope this would not be the case, if it does not appear to be moving ahead successfully at a reasonable cost?

Admiral STEIDLE. I think the most appropriate time would be a major design review that we hold in the summer of '06. At that particular time, we will have the two contractor teams that will enough specificity in their proposals, and we will hold a design review in the summer of '06 for a total review of the program.

Chairman BOEHLERT. Mr. soon-to-be Acting Administrator, thank you and your team very much for an outstanding hearing and exchange. This hearing is adjourned.

Mr. GREGORY. Thank you, Chairman Boehlert.

[Whereupon, at 12:18 p.m., the Committee was adjourned.]

Appendix 1:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Frederick D. Gregory, Deputy Administrator, National Aeronautics and Space Administration (NASA)

Questions submitted by Chairman Sherwood L. Boehlert

Q1. Last year, the Congressional Budget Office (CBO) completed a budgetary analysis of NASA's proposed new vision for space exploration, which concluded that the potential cost growth through 2020, based on NASA's history, is between $32 billion and $61 billion. What specific steps are being implemented to ensure that NASA's cost estimates for space exploration are as accurate as possible? What specific steps are being implemented to identify cost growth risks and manage those risks?

A1. NASA appreciates the analyses performed by the Congressional Budget Office (CBO) in their report *A Budgetary Analysis of NASA's New Vision for Space Exploration* (CBO, September, 2004), which "are intended to illustrate potential upper bounds" to NASA's budget projections for the *Vision for Space Exploration.* CBO assumes a 45 percent cost-growth risk factor, and applies that factor to the costs of human lunar exploration activities and robotic support missions. CBO's derivation of this factor is based on 72 historical NASA programs. The results of the CBO report could represent a "potential upper bound" for cost growth, but CBO does not address what may be the expected levels of cost growth. NASA believes that the expected cost growth will be much less than the 'upper bound' estimated by CBO, and will be manageable while still achieving the goal in the *Vision for Space Exploration* of returning humans to the Moon by 2020. The CBO states in their report, "It is certainly not a foregone conclusion that technical programs such as those involved in NASA's exploration initiative will experience serious cost-growth problems. The Apollo project is a case in point. . .exceeding the budget laid out in 1961 by only about seven percent." NASA disagrees with some of the assumptions used by CBO to arrive at their 'upper bound,' and already has strategies in place to ensure that costs are managed and that actual costs will be no where near the upper bound of potential cost growth estimated by CBO.

The cost of any complex undertaking is highly dependent upon the underlying technical and programmatic architecture. With respect to NASA's new initiatives in human exploration, the Exploration Systems Mission Directorate (ESMD), in partnership with industry through the Concept Exploration & Refinement contracts, has been evaluating various alternative architectures with regards to sustainability, cost, reliability, safety, etc. In order to ensure that cost estimates are credible ESMD is embarking on a three-pronged strategy. First, the Directorate is developing a cost analysis career plan (in partnership with the NASA Cost Analysis Division of the Office of the Chief Financial Officer) that will delineate the knowledge, training, and job experiences that cost estimators should have in order to adequately perform their function. Second, ESMD is funding the development of new and improved cost tools that expand our capability to generate estimates and understand the underlying cost drivers. Third, ESMD is establishing a policy that requires independent cost estimates, both from within and from outside NASA at key decision milestones. This policy also institutionalizes cost estimating as a necessary part of effective program management.

NASA has taken a number of steps to address independent technical and cost assessments at the agency level in addition to the steps identified above. First, the Agency is adding new tools, procedures, and personnel to the Independent Program Assessment Office (IPAO) to independently review projects at critical milestones. The IPAO reports to the Chief Engineer and Chief Financial Officer, both of whom are adding personnel in this area. Second, NASA has revised and released its program management handbook (NPR 7120.5C) which includes clear decision milestones to determine if projects will proceed to the next phases of development. These milestones are supported by independent technical and cost reviews. Third, the Agency strengthened its safety and mission assurance organization by creating an Independent Technical Authority (ITA) at all NASA field Centers and establishing the NASA Engineering and Safety Center to enhance independent safety and engineering oversight. Fourth, NASA has benchmarked its cost estimating practices against other organizations, including Department of Defense, and will be introducing improved earned value management requirements later this summer. NASA has established a policy requiring independent cost estimates at Pre-Non Advocate Review and Non Advocate Review milestones, has implemented Continuous Cost-Risk Management, which requires project estimates to be developed during formula-

tion. This estimate can be referred to during project management reviews and updated at critical milestones.

Q2. In your written testimony you are very cautious in stating that the Shuttle return-to-flight date could occur "as early as May 2005." How certain are you at this point that you can meet that date? Many inside and outside NASA have said that they are less worried about the success of the first flight than they are that something could be learned on that flight that presages future problems. Could you comment on that?

A2. On February 18, 2005, the NASA Space Flight Leadership Council reviewed the progress being made to ensure a safe Return-to-Flight and approved a launch date of May 15, 2005 for STS–114. All major flight hardware is at the Kennedy Space Center in Florida and being processed through a normal pre-launch flow. Meanwhile, the independent Return-to-Flight Task Group (RTFTG) continues to assess NASA's efforts to meet the fifteen Return-to-Flight recommendations made by the *Columbia* Accident Investigation Board (CAIB). The RTFTG met in a plenary session on March 29–31, 2005, to consider the remaining open CAIB Return-to-Flight activities. In the words of RTFTG co-chair Richard Covey, "Right now, we don't see anything that stands in front of the agency that can't be accomplished in order to make the May–June [2005] launch window."

NASA is committed to making the last flight of the Space Shuttle system at least as safe as the Return-to-Flight mission. All flights will be driven by safety milestones. If there is any indication that additional work needs to be done to meet those milestones, then the Space Shuttle program will take whatever measures are appropriate to ensure that those milestones are met—up to and including delaying launches, if necessary.

Q3. You were clear in your testimony today that the Shuttle will be retired by the end of 2010. But in comments to the press, other top NASA officials have been much less firm. Is NASA's position that it will retire the Space Shuttle in 2010? Are there any circumstances under which NASA would fly the Shuttle after December 31, 2010?

A3. The President stated on January 14, 2004: "In 2010, the Space Shuttle—after nearly 30 years of duty—will be retired from service." To enable the 2010 retirement date, NASA is examining configurations for the Space Station that meet the needs of both the Space Exploration Vision and our international partners using as few Shuttle flights as possible.

Q4. You say in your testimony that the Crew Exploration Vehicle (CEV) "promises safer travel." Safer than what? How will you measure that? Will a risk level be specified in the requirements for the CEV?

A4. The Exploration Systems Mission Directorate's Level 1 Crew Transportation System Requirements (Rev D) establishes thresholds and objectives for the safety performance of the Crew Exploration Vehicle (CEV) and its associated human rated launch system. These preliminary requirements establish the failure tolerance design criteria for the system against the loss of successful mission completion, non-life-threatening injuries, or significant damage to the system. The key measure in terms of safety is crew survivability. The preliminary requirements include a requirement that the predicted analytical crew survivability during ascent be 99,9325 percent with a 50 percent confidence level.

The CEV safety thresholds have been established such that the vehicle will be safer than current systems including the Space Shuttle.

Q5. Does NASA intend to close any wind tunnels this year, in FY 2006 or in FY 2007?

A5. NASA will not close any wind tunnels in FY 2005 as directed by Congress in the Conference Report accompanying the FY 2005 *Consolidated Appropriations Act* (H. Rpt. 108–792). However, beginning in FY 2006, NASA cannot sustain the existing suite of NASA ground test facilities and wind tunnels with the FY 2006 aeronautics budget as submitted. Hence, on January 28, 2005, the Aeronautics Research Mission Directorate instituted a corporate management model for its wind tunnel facilities to enable an Agency-wide assessment of these needs. From the existing suite of facilities, the FY 2006 Vehicle Systems Program requires the use of only a few facilities for ground and test flight assets necessary to support aircraft and engine noise reduction, remotely operated aircraft design, development, and operations, and the development of electric (fuel cell) based power systems for an all-electric aircraft.

There are up to 20 ground test facilities and capabilities that may no longer be necessary to support the aeronautics research program, including most of NASA's large wind tunnels and engine test cells. Changes in operational status of these 20 facilities are needed by the start of FY 2006.

Numerous other capabilities/facilities are to be retained and invested in as appropriate. These are the capabilities required to support research activities in Airspace Systems and Aviation Safety and Security Programs and are primarily information technology based infrastructure, such as simulators, communication systems and human factors laboratory capability.

Q6. Your testimony says that the Space Shuttle mission to the Hubble was canceled "based on analysis of the relative risks"? As requested during the hearing by Congressman Ehlers, please provide a copy of this analysis. Can you describe how it differs from the analysis by the National Academy of Sciences in its report on the Hubble?

A6. Please refer to the letter from NASA to Chairman Boehlert dated March 14, 2005, for additional information related to this topic.

National Aeronautics and
Space Administration
Headquarters
Washington, DC 20546-0001

March 14, 2005

Reply to Attn of: Office of Legislative Affairs
KF:leg

The Honorable Sherwood L. Boehlert
Chairman
Committee on Science
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

On March 7, 2005, NASA received the Questions for the Record (QFRs) from the February 17, 2005, hearing before the House Science Committee concerning NASA's Fiscal Year 2006 Budget Request. We understand from your staff that you have requested that we expedite our response to the QFR related to a Space Shuttle servicing mission to the Hubble Space Telescope (HST).

Enclosed is a white paper that outlines an analysis by NASA of the relative risks, operational complexity and the implicit schedule pressure associated with a Space Shuttle servicing mission to HST (Enclosure 1). We have also enclosed a white paper, provided to Members of Congress in March 2004, which describes the factors that led to NASA's decision to take steps to sustain the HST rather than proceed with a Space Shuttle servicing mission (Enclosure 2). As outlined in Mr. Gregory's testimony to the Committee, a number of options are under consideration that may provide the opportunity for NASA to sustain and extend the HST's service life.

NASA's decision not to proceed with a Shuttle servicing mission to HST was difficult. However, the Agency cannot justify the additional risk to the crew that such a unique mission would entail. We must be responsible on all future flights and be fully compliant with the recommendations of the Columbia Accident Investigation Board report.

We hope this information is helpful to the Committee's understanding of NASA's decision-making process with respect to a Space Shuttle servicing mission to the HST. If we can provide any further information, please do not hesitate to contact us.

Cordially,

D. Lee Forsgren
Assistant Administrator
Office of Legislative Affairs

Enclosures

The decision not to pursue a Shuttle servicing mission to the Hubble was based on a relative risk analysis and operational complexity. The National Academy of Sciences (NAS) report recommended a Shuttle-based servicing mission for Hubble, and concluded that a Shuttle flight to Hubble was not significantly more risky than a Shuttle flight to the International Space Station (ISS). Yet while all space flight is inherently risky, there are both on-orbit and ground processing requirements that would be notably unique to a Hubble servicing mission. While similar issues (thermal protection system inspection and repair, contingency Shuttle crew support, and potentially rescue) exist for missions to the ISS, they can be mitigated more easily, in part due to the increased time available for understanding and responding to an emergency situation at the Station. For a Hubble servicing mission, the options and available time for dealing with an on-orbit emergency are greatly reduced, posing additional risk to the mission.

NASA has developed a five-point flight rationale (addressing safety requirements) for Space Shuttle RTF, which is grounded in the recommendations of the CAIB and

predicated on primary hazard control, warning devices and special procedures. The first two elements of that flight rationale *(Elimination of Critical Debris* and *Impact Detection During Ascent)* rely upon Space Shuttle hardware, infrastructure, and procedural improvements that broadly apply to all missions, including those to destinations other than the International Space Station (ISS). However, the efforts of the Space Shuttle program to meet the three remaining elements of the RTF flight rationale *(On-Orbit Debris Impact/Damage Detection; On-Orbit Thermal Protection System Repair;* and, *Crew Rescue)* assume access to the resources of the ISS. Developing the additional capabilities necessary to meet these three elements of the flight rationale for a Hubble servicing mission would entail additional risks above and beyond those inherent in a mission to the ISS.

The ISS provides Space Shuttle managers with three critical capabilities not found in autonomous missions. First, the ISS serves as an independent observing platform for assessing the integrity of the Space Shuttle's Thermal Protection System (TPS). Second, the ISS can operate as an independent working platform from which Space Shuttle crews can conduct repairs to the TPS if necessary. Finally, the ISS provides redundancy as a safe haven platform capable of sustaining a stranded Space Shuttle crew for a significantly longer period of time than the Shuttle alone can.

To apply this same flight rationale to a Hubble servicing mission, NASA would have to develop new capabilities that are analogous to those provided by the ISS. The Orbiter Boom Sensor System would have to be extensively modified, or an alternative capability would need to be created. Specifically, there would have to be new hardware and procedures to provide space-walking astronauts a platform from which to effect repairs to a damaged TPS, without increasing the risk of further damaging the Orbiter. Additionally, a way would need to be found to sustain the crew of a hopelessly crippled Orbiter with limited life-support capabilities long enough for a second Shuttle to be launched on a rescue mission. That rescue mission, in turn, would need to be processed at the same time as the Hubble servicing mission itself, a situation which would be highly complex, would require double the normal workload on ground launch and processing teams, and would put an unprecedented strain on the overall Shuttle system. Finally, a rescue mission would require many unproven techniques, such as emergency free-space crew transfer in space suits while performing Space Shuttle to Space Shuttle station-keeping. Being based at the ISS offers the advantages of multiple hatches, airlocks, and established docking and evacuation procedures, which would afford a shirt-sleeve, nominal transfer of crew from the ISS to the rescue Orbiter.

New capabilities would need to be built, tested, and validated before Hubble had degraded to the point where any reasonable repair effort would be impossible. Seeking to develop and validate these new capabilities in time for Hubble servicing, as well as process a second launch, is contrary to the milestone-driven approach NASA has adopted in response to the CAIB recommendations.

Based on analysis of the relative risks, operational complexity and implicit schedule pressure, in February 2004, NASA decided not to proceed with a Shuttle servicing mission of Hubble. The new NASA Administrator has stated his intention to revisit this earlier decision in light of what NASA learns after the Shuttle returns to flight.

Cancellation of the Fifth (SM-4) Hubble Servicing Mission

Executive Summary

The Hubble Space Telescope (HST) was originally launched aboard the Space Shuttle in 1990, with an as designed mission lifetime of 15 years. Since then the telescope has been serviced or upgraded four times, each requiring a very complex, dedicated Space Shuttle mission and unique HST servicing support equipment. Even before its repair mission in 1993, the HST had generated significant scientific discoveries. The science return from HST has already vastly exceeded the original expectations.

NASA plans continued operation of the HST until it can no longer support scientific investigations anticipated to occur in the 2007-2008 time frame. The telescope's life may, in fact, be extended if NASA is successful in employing operational techniques to preserve battery and gyroscope functions. Meanwhile, NASA is aggressively investigating innovative ways to extend the science lifetime of the HST for as long as possible, including robotic servicing to provide extension of power storage. Current plans are to safely deorbit the HST by a robotic spacecraft by approximately 2013.

Although the HST deployment mission and four subsequent servicing missions were successfully conducted, the Columbia tragedy underscored the inherent risk in each and every Space Shuttle mission and reinforced the need for increased ability to deal with all potential contingencies, particularly catastrophic damage to the Orbiter's thermal protection system (TPS).

Without the benefit of docking at the ISS many new tools, processes, and techniques would be required for inspection and possible repair of the TPS. More significant would be the requirement to dedicate two Space Shuttles to the mission to ensure astronaut safety. In the event of a significant problem with no safe haven for the astronauts to wait as in ISS missions, a second Shuttle would have to be launched and employ untried and uncertified techniques to perform a rescue. Hence, a Shuttle based HST servicing mission presents known additional risks, and offers few options to respond to serious problems in orbit.

Recognizing the increased risks involved in all Shuttle flights following the tragic loss of the Columbia and crew NASA elected to reduce its planned Shuttle manifest to only missions to the International Space Station (ISS). The decision was also made, on the basis of risk, to not pursue a final servicing mission to the HST, but instead to investigate other options to extend the life of the Hubble.

Columbia Accident Investigation Board Findings and Impact on Future Missions

The Columbia Accident Investigation Board presented NASA with 29 recommendations, 15 of which were required to be completed before the Space Shuttle could return to flight. Highlights of these flight-critical recommendations included elimination of damaging insulation shedding from the external tank -- the cause of the Columbia tragedy -- ascent imaging, on-orbit inspection, and thermal protection system tile and Orbiter leading edge repair. NASA will satisfy all of these recommendations before it launches STS-114, the next Shuttle mission. The Board stressed that the Space

Shuttle is still a developmental vehicle and that risk and risk mitigation must be treated accordingly. NASA's original vision was to fly the Shuttle to mid-decade or 2020 for a total of 75-80 more flights. NASA fully accepts the Board's recommendation and balancing mission criticality against possible loss of crew and vehicle, consciously decided to retire the Space Shuttle after the completion of the International Space Station (ISS), recognizing that the best risk mitigation strategy is to fly less.

In addition, NASA realizes that a "safe haven" in space capability is required. This "safe haven" capability goes beyond compliance with the Columbia Accident Investigation Board recommendations and is designed to increase crew safety during the remaining Space Shuttle missions. Should damage occur to the Shuttle thermal protection system that can not be repaired and that would preclude safe reentry, the crew will be able to shelter at the ISS until another vehicle can be readied for rescue. Agency policy will require each Space Shuttle mission to have backup rescue capability. "Safe haven" is the ultimate recognition that, while NASA will make the Space Shuttle as safe as possible, the Columbia tragedy has taught us that there are still significant risks inherent in Space Shuttle launch, orbit operation, and reentry.

Unique Requirements and Increased Risk in the Hubble Servicing Mission

Whereas tools, techniques, and procedures would be similar on each ISS mission; e.g., inspection, thermal protection system repair, safe haven readiness, and rescue scenario, an HST servicing mission would have unique requirements, both on-orbit and in ground processing. Options for dealing with an on-orbit emergency are reduced and decisions for reacting to any emergency would have to be made quickly. These two considerations, and the attendant schedule pressure on the flight crews and support teams, add considerable additional risk.

Lack of Significant Safe Haven

The areas of additional risk relate to the ability to provide "safe haven" while inspection, repair and potential rescue are undertaken, and to the procedures for inspection and repair themselves. It has been projected that a typical Space Shuttle flight crew of seven astronauts could stay aboard the ISS for up to ninety days, if warranted, due to an emergency situation on the Space Shuttle. This safe haven capability allows the flight crew and ground teams to consider all options, determine the best course of action, take the time required to understand the cause of the failure and affect repairs, or send the appropriate rescue vehicle with the right equipment to bring the crew home. Clearly, rushing this process would introduce considerable new risk and in the worse case result in the loss of another vehicle.

In the case of a Hubble servicing mission, the amount of stay time on orbit is significantly shorter due the limited stores of cryogenic oxygen on the Orbiter. Therefore, other measures would be required. Specifically, a second Space Shuttle on an adjacent launch pad would have to be specially prepared, uniquely configured to launch expeditiously if required to perform a rescue mission. This scenario raises several concerns, addressed in the paragraphs below.

Unprecedented Double Workload for Ground Launch and Processing Teams

Two vehicles would be processed for essentially the same launch date. Any processing delays to one vehicle would require a delay in the second vehicle. The launch countdown for the second launch would begin before the actual launch of the first vehicle. This short time period for assessment is a serious concern -- it would require a highly complex process to be carried out in parallel, and it would not permit thorough assessment by the launch team, the flight control team, and the flight crew.

No Changes to Cargo or Vehicle Feasible

Because of the very short timeframe between the launch of the first vehicle and the requirement for a rescue flight, no significant changes could reasonably be made to the second vehicle or the cargo. This means that it would not be feasible to change the cargo on the second Space Shuttle, to affect a repair to the first Shuttle, add additional rescue hardware, or make vehicle modifications to avoid whatever situation caused the need for a rescue attempt in the first place. Not having sufficient time to make the appropriate changes to the rescue vehicle or the cargo could add significant risk to the rescue flight crew, or to crew transfer. The whole process would be under acute schedule pressure and undoubtedly many safety and operations waivers would be required.

Rescue Mission

Space Shuttles routinely dock with the ISS; Soyuz evacuation procedures are well trained. These represent the normal operations mode today supported by extensive training, analysis and documentation. A rescue from the ISS, with multiple hatches, airlocks, and at least one other vehicle available (Soyuz), is much less complex and risky than that required by a stranded Space Shuttle being rescued by a second Space Shuttle.

In response to a question by the Columbia Accident Investigation Board, NASA analyzed a hypothetical rescue mission between two Space Shuttles and found that the effort would have required many unproven techniques, such as emergency free-space crew transfer in space suits while performing Space Shuttle to Space Shuttle station-keeping while traveling 17,500 mile per hour above the earth. These major safety risks are not incurred during rescue from the ISS.

Tile Survey (expanded inspection requirements) and Thermal Protection System Repair

The current inspection method for acreage tile, gear door seals, and the elevon cove is to photograph these areas from the ISS during rendezvous. To support an HST servicing mission, NASA would have to develop a new method for inspecting these critical areas using an Orbiter boom. Unvalidated autonomous boom operations represent an unknown risk. NASA's current planned TPS repair method for an ISS-based repair uses the ISS robotic arm to stabilize an EVA crew person over the worksite. These assets are not available for an HST servicing mission, so NASA would have to develop a single-use alternate method for stabilizing the crewmember. This method would have to provide greater stability than the current ISS option under development to protect both the crewmember and the other TPS areas from additional damage. Such a concept represents a challenging undertaking, which could take

months or years to develop in order to meet safety and mission assurance standards/requirements.

Return to Flight and ISS U.S. Core Complete Timeline

In the process of addressing the Columbia Accident Investigation Board recommendations and implementing additional improvements to achieve the safest flight possible, NASA has uncovered a number of problems that had previously gone undetected. The removal and replacement of unsafe hardware has deferred Space Shuttle launch milestones. NASA projects the first opportunity for a Space Shuttle launch to the ISS to be in March 2005. Eight flights are scheduled to meet our international commitments, the assembly of the U.S. core segments of the ISS. Given the ISS assembly schedule, the earliest NASA could launch a servicing mission to the HST, based on requirements for daylight launch to fully assess ascent conditions by imagery and thermal constraints when docked to ISS, would be Spring 2007.

Based on the evaluation of the engineering data on the HST, the lifetime of the Observatory on orbit is ultimately limited by battery life, which may extend in to the 2007-2008 timeframe. Scientific operations are limited by gyroscope lifetime that is more difficult to predict. If all of the NASA effort is concentrated on a Shuttle servicing mission, every step in the process must be successful with no allowance for schedule slips. Before launch all of the recommendations of the Columbia Accident Investigation Board must be met. The launch conditions must be perfect, and all tailored HST mission unique components must be in place with very tight schedule constraints. If any of the many elements do not develop as planned, the telescope may cease operations before a successful mission could be mounted.

Hubble Space Telescope's Scientific Legacy

Not since Galileo turned his telescope towards the heavens in 1610 has any event so changed our understanding of the universe as the deployment of the Hubble Space Telescope. From its orbit above Earth's atmosphere, the HST is free from the atmospheric turbulence that all ground-based telescopes must contend. Thus, HST has been able to return images of astounding clarity and sensitivity. HST imaging and spectroscopy have resulted in remarkable scientific achievement, including the determination of the changing rate of expansion of the universe and detailed studies of forming galaxies, black holes, galaxy hosts of gamma-ray bursts and quasars, active galactic nuclei, protostars, planetary atmospheres, and the interstellar and intergalactic medium. Scientific results have significantly surpassed original expectations. By 2005, the HST will have fulfilled every one of its scientific objectives and top-level technical requirements. Moreover, the Hubble will continue to collect observations for several more years. Even after the HST is no longer in service, the rich archive of HST data (already more than 100,000 observations of 20,000 unique targets) will continue to provide new discoveries for the years to come, with full support by NASA for both archive operations and research grants.

Future Plans for Hubble Space Telescope and Astronomy

Astronomy is a critical part of the NASA's exploration initiative. NASA is aggressively investigating innovative ways to extend the science lifetime of the HST for as long as possible, including a possible robotic servicing option. We are receiving several responses to our recently released Request For Information (RFI) on HST End of Mission Alternatives soliciting concepts for robotically-provided battery power extension. Indeed, this option appears to have greater likelihood of success than the possibility of accomplishing all the recommendations of the Board in time for a successful Hubble servicing mission.

HST is not NASA's only portal to the stars. It is one of many telescopes used by astronomers to study the universe using various apertures and wavelength bands. Hubble, primarily used for observations of visible light, is one of the four orbital "Great Observatories" designed for use across the spectrum. The other three include the Compton Gamma-Ray Observatory (1991-2000), the Chandra X-Ray Observatory, and the infrared Spitzer Space Telescope. In the years since Hubble was launched with its 2.4-meter aperture, many new ground-based telescopes have been built with larger apertures that enable observations with increasingly higher angular resolution, though subject to the blurring effects of Earth's atmosphere.

The James Webb Space Telescope (JWST) program has been strengthened to assure a 2011 launch date. Once on orbit, this advanced technology infrared telescope will provide insight into the a region of the spectrum where we will be able, like never before, to view the formation of the earliest galaxies. The JWST will build on the successful science of the Hubble via the most advanced instrumentation and a larger 6.5 meter aperture.

The following table lists larger optical telescopes now or soon to be available along with Hubble and also several examples of large telescopes available or in development for observations at other wavelengths.

Examples of Large Telescope Facilities Available or In Development

Radio/MM	Infrared	Optical+IR (aperture, meters)	Ultraviolet	X-Ray	Gamma Ray
VLA	Spitzer	SALT (11.0)	HST	Chandra	GLAST
GBT	SOFIA	Keck I, II (10.0)	GALEX	XTE	SWIFT
ALMA	JWST	Hobby-Eberly (9.2)		XMM-Newton	
Arecibo	HST	LBT (8.4 x 2)		Astro-E2	
FCRAO		Subaru (8.3)		SWIFT	
VLBA		VLT (8.2 x 3)			
CSO		Gemini (N & S) (8.1)			
		HST (2.4)			

The HST program has provided a significant amount of funding support for U.S. astronomers; in fact, it is currently providing approximately 20% of all direct grant support. After HST observations have ceased, NASA plans to continue to support ongoing grants and to offer new grant support for HST archival research until a similar grant program is in place for the upcoming James Webb Space Telescope program.

This will ensure stability to the research community and full use of the rich HST data archive throughout this period of transition.

Conclusion

The cancellation of HST-SM4 was a difficult decision. HST is producing world-class science. However, NASA cannot justify the additional risk that such a unique mission would entail, based on what must be done to assure greatest protection to the crew. It is increasingly apparent that our choice is to either fully comply with the Columbia Accident Investigation Board report or conduct the servicing mission, but not both. We must be responsible on all future flights and be fully compliant. NASA will continue to aggressively pursue options to extend the science lifetime of the Hubble by means other than Shuttle servicing. NASA will continue to be a major supporter of astronomy in the future as the Agency continues to explore the universe.

Q7. How does NASA intend to use the money proposed for crew and cargo services for the Station? When does NASA expect the first commercial cargo mission to launch? What is NASA specifically doing to develop additional service providers beyond the Russians?

A7. A portion of the money in the ISS Cargo/Crew services line will likely be used to procure Soyuz crew transportation services, if Congress agrees to a legislative solution to the *Iran Nonproliferation Act of 2000* (INA). Over the last several months, NASA has been participating in an interagency coordination process related to INA, which seeks to protect our nonproliferation objectives while advancing potential U.S. cooperation with Russia on the Vision for U.S. Space Exploration. The results of this interagency coordination process will be presented to Congress shortly.

The balance will be used to acquire commercial cargo transportation services. NASA is developing a Request for Proposal (RFP) to be released in 2005. The RFP will seek to develop an initial operating capability for commercial services for cargo transportation to the ISS before Space Shuttle retirement. NASA will also utilize partner capabilities for cargo transportation. The European Automated Transfer vehicle will make its first visit to the ISS in 2006. The Japanese H2A Transfer Vehicle is also in development.

Q8. NASA has discussed the possibility of launching the James Webb Space Telescope on a foreign rocket, the Ariane. It is my understanding that the Europeans have offered to provide the Ariane launcher as well as an infrared instrument in exchange for 15 percent of the tasking time on Webb. Is this accurate? Please provide the terms and conditions for this arrangement. The President's Space Transportation Policy requires that use of a foreign launcher be coordinated through an interagency process. Has the interagency coordination process been initiated? When does NASA need to know which launcher it will use if it is to deliver Webb on schedule and within cost?

A8. The James Webb Space Telescope (JWST) is envisioned to be an international mission involving significant contributions from the European Space Agency (ESA) and the Canadian Space Agency (CSA). This is consistent with the *Vision for Space Exploration,* announced by the President on January 14, 2004, which directs the pursuit of opportunities for international participation to support U.S. space exploration goals. NASA pursues foreign cooperation on science missions for mutual scientific benefit on a no-exchange-of-funds basis, and considers scientific merit, engineering practicality, industrial capability and export control feasibility and compliance in assessing the potential contributions of foreign partners.

ESA proposes to contribute significantly to the JWST mission. On JWST, foreign scientists are likely to receive significant amounts of science (measured in terms of observing time on the telescope). Case in point is the Hubble Space Telescope, where European scientists have won slightly more than 15 percent of the total observing time according to scientific merit through the competitive time allocation process. Therefore, it is fair and logical that NASA exact tangible contributions to JWST from foreign space agencies in proportion to the amount of science that the foreign scientists they sponsor and represent are likely to receive. Hence, NASA seeks about a 15 percent contribution from ESA.

Discussions regarding possible ESA contributions have explored many possibilities. ESA proposes to contribute a near-infrared spectrometer (NIRSpec), an optical bench assembly for a mid-infrared instrument (MIRI), an Ariane 5 ECA launch vehicle and launch services with a launch from Kourou, French Guiana, and a small number of support staff in residence at the JWST science operations and control center. The Ariane presents a small number of simple interfaces, and thus is an attractive option from a technical viewpoint that reduces mission risk. It is also worth substantial value by itself such that the total value of ESA's proposed contribution package is approximately 15 percent of the total mission cost.

Launch of any U.S. government payload on a foreign-supplied launch vehicle is subject to interagency review, in accordance with NSPD 40, National Space Transportation Policy, dated December 21, 2004. This interagency review has been completed, clearing the way for what is known as the C–175 process by which the Department of State grants authority to NASA to negotiate with ESA the terms of cooperation on JWST.

JWST is approaching mission preliminary design review (PDR) in 2006. Many subsystem design details depend on knowing the launch vehicle envelope and environment. Therefore, the designation of the launch vehicle for JWST is needed now to preserve the launch schedule.

Q9. NASA was provided $15 million in the FY 2004 Appropriations Act for crew safety and survivability by Congressman Hall. Please provide a report on how

this money was spent and how the results will improve safety and survivability of human space flight.

A9. The Shuttle program reviewed a wide range of options for addressing crew survivability, including major hardware modification of the vehicles. The evaluation process was revised in light of the *Vision for Space Exploration,* which calls for Shuttle retirement after assembly of the ISS is complete, planned for the end of this decade.

Crew survivability options encompass a range of means that could be implemented to ensure crew safety and survivability and test new technologies as we move forward with the Vision for Space. The Program identified a series of options that can be accomplished and are being pursued.

The following investment areas are being implemented. Items with an asterisk ("*") denote potential applicability to exploration initiatives.

Improved Individual Tracking Device—will significantly increase the location accuracy and acquisition time for any contingency crew rescue operations including unconscious crew members. This effort is currently being reviewed and modified by the Department of Defense (DOD) for completeness and accuracy.

***Portable Radio Communication Device with GPS—**will enable quick identification and location of conscious crew members during rescue operations. This device will transmit crew member identification and location data to multiple DOD Search and Rescue operation entities.

***Improve ISS Rendezvous Radar—**place an active radar transponder on ISS to aid in Orbiter dock/undock operations. This effort provides one clean, uninterrupted sensor source for all phases of rendezvous. Hardware changes would be on the ISS side only. The current system becomes noisy due to radar wandering over the large surface of ISS. A transponder on ISS would eliminate that noise, providing for pristine relative navigation data for the manual phase and docking, thereby increasing the range at which the Orbiter could acquire a radar lock. It also improves navigation performance during the manual phase. A study of this proposal was completed and has been incorporated into a larger autonomous rendezvous and docking effort.

Continuation of the CAIB Directed Crew Survivability Working Group—performing analysis and reconstruction of STS–107 post break-up crew cabin dynamics and forensics. To be included is an analysis/reconstruction of the STS–51L crew compartment dynamics and forensics. This actual flight reconstructed data will be utilized by flight operations in future procedure development and possible crew compartment structural/thermal hardening for future vehicle design.

Egress Procedure Development—Develop crew operational procedures to support crew egress in the event of a catastrophic vehicle break-up where the crew cabin has separated intact. Testing the new procedures entails changes to the program requirements documentation and facility modifications to the Crew Compartment Trainer (CCT). Activity is in work and procedures will be made available in FY 2005.

Summary:

	Study	Implementation
1. Improved Individual Tracking Device	in-house	$9 million
2. Portable Radio Communication	in-house	$1 million
3. Improve ISS Rendezvous Radar	$1.5 million	TBD
4. Continuation Crew Survivability Working Group	$2.5 million	TBD
5. Egress Procedure Development	in-house	$100K
Total	$4.0 Million	$10.1 Million
Contingency		0 .9
Total		**$15.0** Million

Q10. In your testimony, you state that improved audit results "could be achieved on the FY 2006 financial statements." How likely is that? What progress toward a clean audit opinion do you hope to make this year? What specific actions is NASA taking to ensure that its financial information is reliable in the future? Please describe the actions planned for the next six months and any longer-term plans to improve the accuracy of financial information.

A10. NASA has developed and implemented a work plan aimed at correcting the material weaknesses and reportable conditions published in the FY 2004 Financial Statement Audit report; however, it will take time to fully implement all of the identified corrective actions. Nevertheless, NASA is aiming at gradually and consistently improving its audit performance, which includes a reduction in the number of identified material weaknesses and reportable conditions. Subsequently, NASA's objective is to receive increasingly positive audit results in each of the following years, possibly starting with a "qualified" opinion and ultimately ending with a sustainable "unqualified" opinion.

The objective for this current year is to begin the reduction of material weaknesses and reportable conditions.

One of our near-term goals is to eliminate the material weakness on the reconciliation of Fund Balance with Treasury in the FY 2005 audit report.

Q11. Last year, NASA provided two different draft versions of a Financial Management Improvement Plan to this committee. We understand that a third version is being developed. What is the status of this plan and when do you expect it to be finished?

A11. NASA is in the process of coordinating its overall plan to improve financial management with NASA's Office of Inspector General and the Office of Management and Budget. NASA wants each of those offices to have the opportunity to review and comment on the plan. Once all of their suggested comments are incorporated into the revised document, NASA will deliver the financial management improvement plan to the Committees later this year.

Q12. Has the budget for NASA's Chief Financial Officer (CFO) been reduced for FY 2005? If so, by how much was it reduced and what ramifications does this reduction have on NASA's efforts to improve its financial management? Does the FY 2006 budget increase or decrease the CFO's budget request?

A12. Agency-wide reductions across all Corporate G&A activities were imposed for FY 2005 and FY 2006 to help accommodate costs associated with the Space Shuttle Return-to-Flight activities. As a result, the staffing plan in the Office of Chief Financial Officer (OCFO) and the Center's Financial Offices was impacted. Additionally, the Agency's Integrated Financial Management Program was reduced by 37 percent or $41.5 million in FY 2005, and $7.8 million in FY 2006. This cut impacted the scope and schedule of the Asset Management activity. A revised scope and schedule reflecting the new funding profile is still in development.

Q13. What effect will NASA's Earth Science cut in FY 2005 and its proposed cut for FY 2006 have on the overall climate change research program? To what extent did the other agencies involved in climate change research participate in the decisions to make these cuts? What criteria did you use to determine that the cuts did not adversely affect anything "essential"? Which missions does NASA plan on scaling back, delaying or canceling as part of this reduction in funding? Are there any new Earth Science missions planned for the future that were not already part of the FY 2005 budget submission?

A13. The reductions to NASA's Earth Science programs in FY 2005 and FY 2006 should not greatly affect the Climate Change Science Program (CCSP); NASA's role in research and the generation of synthesis reports (the principal near term product of the CCSP) will continue as before. NASA engaged the other CCSP agencies in discussions of the changes to NASA's budgets as they were being developed. The principal criterion employed was to do the least harm to current commitments and satellite programs currently under development. In the FY 2005 budget, the Ocean Vector Winds mission was canceled, and the Global Precipitation Measurement mission was delayed two years. In the FY 2006 budget request, the Glory mission is re-scoped to instrument development only with an expectation that it will fly on the NPOESS system, and the Landsat Data Continuity Mission now reflects the provision of two-advanced land imaging instruments for flight on the NPOESS system. Funding for technology development and future mission concepts was reduced. No new missions have been identified that were not part of the FY 2005 budget submission. NASA eagerly awaits the decadal survey report of the National Research Council, as well as recommendations from our own strategic roadmapping team for guidance on identification of potential future missions.

Q14. Your FY 2006 budget justification (page EC 2–6) refers to NASA's "reassessment of the ISS final configuration." Not quite a month ago (January 26, 2005), NASA and other ISS partners announced that all of you endorsed the "Multilateral Coordination Board approved ISS configuration." Is that the con-

figuration you are now reassessing? When will the final configuration of the space station be agreed upon? What changes to that configuration are being considered by NASA? In particular, are you reconsidering whether to launch the centrifuge? How important is the centrifuge to research planned by NASA and its partners?

A14. The International Partnership Heads of Agency (HOA) met January 26, 2005, to review the status of ongoing ISS operations and NASA's plans for Shuttle return-to-flight. The HOA endorsed the Multilateral Coordination Board-approved ISS configuration. The partners reaffirmed their agencies' commitment to meet their ISS obligations; to complete Station assembly by the end of the decade; and to use and further evolve the ISS in a manner that meets their research and exploration objectives.

NASA is now examining configurations for the Space Station that meet the goals of the *Vision for Space Exploration* and the needs of our international partners using as few Shuttle flights as possible. The timeline for completion for these studies will be determined by the new NASA Administrator.

The Centrifuge remains on schedule for completion and delivery to Kennedy Space Center on time for a 2009 launch. NASA requirements for the Centrifuge are derived from the Human Systems Research and Technology (HSR&T) theme within the Exploration Systems Mission Directorate (ESMD). ESMD recently conducted a Zero-Based Review of the entire HSR&T portfolio in order to ensure that future efforts will be focused on research that directly supports the future safety of the astronauts.

Q15. Does NASA have any back-up plan for providing rescue capability for the Space Station if changes are not made to the Iran Nonproliferation Act*?*

A15. With the exception of the Space Shuttle, the Soyuz is the only other proven spacecraft capable of performing crew transportation and rescue operations for the ISS. If the Soyuz were to become unavailable to NASA, the operation of the Space Station would be limited to those periods of time when the Shuttle could be docked to the ISS.

Q16. How confident are you of the accuracy of the proposed CEV budget for FY 2006, which officials have described as a "placeholder"? What is the range of possible costs for the CEV in FY 2006?

A16. NASA's Exploration Systems Mission Directorate, in partnership with industry through the Concept Exploration & Refinement (CE&R) contracts, has been evaluating various alternative CEV concepts with regard to safety, sustainability, cost, reliability, etc. The culmination of this evaluation process will be the Constellation Mission Systems Spiral 1 Milestone–A Review. At this review, Exploration Systems will present to the NASA Program Management Council a range of cost estimates for CEV. This range of possible costs will be the result of industry inputs through the CE&R contracts and internal NASA studies, validated by an independent cost assessment conducted by the NASA Cost Analysis Division with assistance from the Independent Program Assessment Office. Currently, the Spiral 1 Milestone–A Review is planned for July 2005.

In addition, Exploration Systems is in the process of procuring a minimum of two contractors to complete preliminary design and perform a risk reduction demonstration in 2008. These contracts will be signed in September 2005. At this time, all information and analyses indicate that Exploration Systems will be able to perform preliminary design activities and initiate development of risk reduction demonstrations in FY 2006 within the proposed budget.

Q17. As Admiral Steidle has described, NASA is using an unusual procedure for the CEV—going out with initial contracts before many parameters of the vehicle are nailed down. What are the risks and advantages to that approach?

A17. The capabilities and technologies developed to extend, in an affordable and sustainable manner, human presence beyond low-Earth orbit to the Moon, Mars, and beyond will require NASA to respond flexibly to new scientific discoveries and incorporate new technologies, while minimizing risk and avoiding costly redesign. In order for ESMD to execute the *Vision for Space Exploration* effectively and affordably, its governing acquisition policies draw on the best processes from the DOD, Naval Sea Systems (NSS), and NASA acquisition models. Additionally, ESMD's use of the evolutionary acquisition concept of spiral development allows this flexibility. In spiral development, the overall program is broken up into a series of intermediate goals, each addressed by a spiral. Because it is not realistic to define all variables precisely now, NASA's plan is to separate the acquisition strategy for

Moon and Mars exploration into a number of smaller acquisition programs called spirals. Each intermediate spiral will usher in a set of major new capabilities in support of the *Vision for Space Exploration.* These spirals will be structured based on specific requirements, well-defined goals and end points, then-current technologies, management risks, executable budgets, and knowledge gained from prior in-space activities. The spiral development approach builds on experience gained in early spirals to provide end points for the subsequent spirals. It also allows flexibility in responding to scientific discoveries and program direction and the ability to incorporate newly developed technologies into subsequent spirals through a preplanned integration strategy.

The acquisition strategy for a Spiral 1 CEV is using a phased approach. The criteria for entering the next phase will be based on approval of the CEV Acquisition Strategy and an Independent Cost Assessment. By the end of FY 2005, NASA expects to award two contracts for Phase I that will direct industry to:

- Conduct a flight demonstration program to validate industry's capability to perform on cost, on schedule and on performance. Additionally, the demonstration will be part of the overall CEV risk mitigation strategy.
- Evaluate NASA's Exploration Systems Research and Technology, Human System Research and Technology, and Prometheus Nuclear Systems Technology themes for potential CEV program integration as part of a concerted effort to improve system effectiveness and affordability.
- Conduct a series of trade analyses on critical performance drivers for the purposes of identifying threshold and objectives for Phase 2 of the CEV contract. Affordability, sustainability, and extensibility to future spirals will be the focus of the analyses.
- Participate in a NASA-led System Readiness Review and Preliminary Design Review for the human-rated CEV.
- Provide an iterative analysis of cost, risk and performance based on realistic timelines and estimates of cost.
- Provide a risk management plan, which will mitigate program uncertainties by establishing priorities, options, adequate margins of safety, and "off-ramps."

CEV Phase 1 actually began with a draft Request for Proposals (RFP) released in January 2005 seeking industry, academia and NASA Center inputs. A final RFP was released March 1, 2005, with planned contract award in September 2005. CEV Phase 1 ends with a planned down select to a single prime contractor in late 2008. Phase 2 of the CEV acquisition calls for a single contractor to complete the development, test, and deployment of a human-rated CEV. After completion of Phase 2, the contractor shall provide as government options, sustaining engineering services and production capability to support additional flights and additional CEV spacecraft. The government may elect to perform a down select at any time or not to select either contractor after 2008. ESMD has developed a Single Acquisition Management Plan documenting ESMD's Overarching Acquisition Strategy for Constellation Systems.

The benefit of this phased approach is that Milestone A activities, specifically trade studies in major areas affecting affordability, risk, schedule, and performance, will enable ESMD to determine more achievable requirements for the next Phase of development. This approach also helps to anticipate and mitigate risk.

Q18. NASA's FY 2006 budget basically cancels the Glory mission while allowing work to continue on the instrument. Our understanding, though, is that the contract for the satellite will actually be canceled this month. Is that right? How likely is it that NASA will find another satellite on which to launch Glory?

A18. In FY 2005, NASA is continuing development of the Aerosol Polarimetry Sensor (APS) and Total Irradiance Monitor (TIM) instruments and continuing the contract effort to refurbish the Vegetation Canopy Lidar bus as a dedicated spacecraft for Glory. NASA is currently assessing launch options for both dedicated and comanifested launch vehicle configurations.

Q19. If the Shuttle's failure rate in the past (two failures in 113 flights) is taken to be the best estimate of its future rate of failure, a simple calculation shows that the probability that we will lose another Shuttle in 28 flights is more than 41 percent. Does this seem accurate to you? What is NASA's estimate of the probability that another Shuttle will be lost over the next 28 flights? Over the next 20 flights?

A19. Through implementation of NASA's Return-to-Flight activities, the Agency has made substantial organizational and technical improvements that we believe will reduce the failure rate of the Shuttle below the historical level. This includes redesigns to address the cause of the *Columbia* accident and improvements in our knowledge of the state of the vehicle during various mission phases. We have also improved our ability to address the inherent risk of human space flight with a thorough review of individual and integrated risks. However, even after we have returned the Shuttle to flight and examined the data from the initial missions, it will still be difficult to estimate the actual risk that a given future mission will be lost.

Q20. At the hearing, Mr. Jennings made the following statement regarding the budget and the number of employees the agency projects it will need. "Going into '07, we are budgeted for about 2,000 less than that [18,000 employees], and over the next two years, we are going to work to understand our exploration program, and where that competition lies, and our assumption is we will remain close to the 18,000 during the—through the run-up." Please clarify this statement. Specifically, how many employees does the agency assume for each year of the five-year budget projection?

A20. The President's FY 2006 Budget contains only workforce currently known to be funded. It does not include the estimated impact of future Exploration Systems competitive decisions or of other Transformation or reimbursable activities that may affect the size of the funded workforce. The FTE in the FY 2006 Budget are:

FY 2005: 19,227 (funded by programs and G&A)
FY 2006: 18,798 (funded by programs and G&A)
FY 2007: 16,738 (funded by programs)
FY 2008: 16,715 (funded by programs)
FY 2009: 16,586 (funded by programs)
FY 2010: 16,415 (funded by programs)

As to the need for workforce in addition to that currently funded by programs, we can only estimate the results of the ongoing activities that will define such needs. These include competitions for major elements of work associated with the Exploration program and all other Transformation activities underway. Within those bounds of uncertainty, we estimate that the NASA workforce funded by programs as we move into FY 2007 could be as much as 2,000 lower than it is today. Beyond that point, as the Exploration program ramps up, and as Centers transform themselves to facilitate bringing in non-NASA work aligned with their capabilities, it is possible that the NASA workforce may grow back to where it is today or higher. However, the skill mix and distribution of that workforce will almost certainly be different.

There is still a significant amount of FY 2007 programmatic money not yet assigned. This relatively high level of uncertainty was caused by major changes to the workforce. Planning assumptions between the FY 2005 and FY 2006 budgets:

1. The *Vision for Space Exploration*
2. Requirements for the safe return-to-flight of the Space Shuttle
3. Reprioritization within the major program areas (Mission Directorates)
4. An increased emphasis on competition to identify the optimum mix of civil servants, contractors and university employees performing NASA work
5. An effort to maximize the resources available for direct mission objectives vs. indirect support functions

There are ongoing efforts to match needed skills with funded work. In addition, there will be billions of dollars of work available for competition as the Exploration program proceeds with its overall program definition, as well as its systems engineering and integration effort and Crew Exploration Vehicle activity. There will also be work available in various competitive science areas, such as the Discovery and Mars programs.

NASA's ongoing health assessment of its core competencies may result in the application of additional program resources to sustain critical workforce. It is anticipated centers will pursue reimbursable work for non-NASA customers in their areas of special competence. Centers may also consider alternative management structures for more flexibility to pursue reimbursable tasks.

As a result of these efforts, many of the FTEs not yet supported will likely be matched with funded requirements. It is also true that a significant number may not be, at least by the start of FY 2007. The best we can do is to offer an estimate based on what we know now and our judgment about how and when the various

issues in the planning process will be resolved. We are working to reduce the uncertainty as quickly as possible.

Questions submitted by Representative Bart Gordon

Q1. What was the rationale for the policy decision to accept a multi-year gap after the Shuttle is retired during which time the United States will have no currently identified U.S. means of getting its astronauts into space and to and from the International Space Station?

Q1a. Was it budgetary?

Q1b. If not, what was the rationale?

A1a,b. It is important to note that the President's *Vision for Space Exploration* called for the Crew Exploration Vehicle to be ready no later than 2014. Administrator Griffin has stated his determination to endeavor to have the Crew Exploration Vehicle ready earlier than 2014, thus reducing any potential "gap."

The decision to not guarantee a U.S. means of getting astronauts into space immediately following Space Shuttle retirement was informed by budgetary, technical and programmatic factors. These included:

- continuing concerns about Shuttle safety and the need to recertify the Shuttle if it flew after 2010,
- assessments of how long the Shuttle was needed to assemble the Space Station,
- the Space Shuttle's $4 billion to $5 billion annual operating costs,
- the cost and time required to develop a new U.S. capability to launch astronauts, and
- the disadvantages of having no guaranteed alternative U.S. access to space immediately following Shuttle retirement.

Q1c. What alternatives to a gap were considered, and why were they rejected?

A1c. Alternatives were assessed, including not retiring the Shuttle, retiring the Shuttle immediately without returning to flight, and mandating the CEV be ready by the time the Shuttle retired. These alternatives were rejected due to such factors as excessive cost, inability to meet international commitments, and technical risk.

Q1d. If during the multi-year "gap" period, the Soyuz spacecraft becomes unavailable for either geopolitical or technical reasons, what is your backup plan for providing U.S. astronaut access to space/ISS?

A1d. Possible alternatives to the Soyuz include potential commercially developed U.S. services that NASA has procured through its ISS cargo and crew program. NASA intends to issue its first RFP under this program in the summer of 2005. If the Soyuz were unavailable to NASA and no commercial services were available, the operation of the Space Station would be limited to those periods of time when the Shuttle could be docked to the ISS.

Q2. Given the existence of the Iran Nonproliferation Act *as public law since 2000, what was the rationale for continuing to baseline the Russian Soyuz as the only means of crew rescue for the International Space Station (ISS) for the duration of the ISS program?*

A2. Over the last several months, NASA has been participating in an interagency coordination process related to INA, which seeks to protect our nonproliferation objectives while advancing potential U.S. cooperation with Russia on the Vision for U.S. Space Exploration. The results of this interagency coordination process will be presented to Congress shortly.

The utilization of the Soyuz spacecraft as the baseline crew rescue vehicle of the ISS is a result of an evolution of capabilities, partner commitments, costs challenges, the *Columbia* tragedy and changes in national priorities. As one of the ISS partners, the Russians have always been committed to providing a crew rescue capability for the initial years of ISS operation. The Soyuz is a tested, reliable and available capability. We believe our resources are better spent utilizing a proven capability, rather than spending time and money to develop a new one.

In order to facilitate the continued use of the Soyuz crew rescue capability, the Addendum to the 1996 Balance Agreement, which covers necessary Russian services through 2005, was negotiated last year and completed interagency concurrence on January 26, 2005. The agreement covers "habitation" through December 2005 and

crew rescue through April 2006. Currently, there is on-going interagency coordination on negotiation of a comprehensive re-balance. This coordination includes the development of an approach that would allow NASA to procure certain space goods and services from Roskosmos while maintaining a strong stance on nonproliferation issues.

Q2a. What is your backup plan in case the Soyuz becomes unavailable?

A2a. The Soyuz spacecraft and Soyuz rocket booster have demonstrated a remarkable reliability record over their lifetime of operations. With the exception of the Space Shuttle, the Soyuz is the only other proven spacecraft capable of performing crew transportation and rescue operations for the ISS. Possible future alternatives to the Soyuz may include commercially developed U.S. services that NASA has procured through its ISS cargo and crew program. NASA intends to issue its first RFP under this program in 2005. If the Soyuz were unavailable to NASA and no commercial services were available, the operation of the Space Station would be limited to those periods of time when the Shuttle could be docked to the ISS. There are no plans for this mode of operation at this time.

Q3. What are the specific options under consideration by the interagency team examining alternatives for dealing with the Iran Nonproliferation Act*'s impact on the International Space Station?*

A3. As the United States implements the Vision for U.S. Space Exploration, the Administration recognizes the necessity for effective cooperation with Russia to further our space exploration goals. At the same time, it is imperative that we maintain appropriate U.S. nonproliferation policy and objectives in our relationship with Russia. Over the last several months, NASA has been participating in an interagency coordination process related to INA, which seeks to protect our nonproliferation objectives while advancing potential U.S. cooperation with Russia on the Vision for U.S. Space Exploration. The results of this interagency coordination process will be presented to Congress shortly.

Q4. NASA has encouraged contractors bidding on the Crew Exploration Vehicle (CEV) project to include international participants on their industry teams. However, it appears that NASA is not seeking or expecting cost sharing by the governments of the non-U.S. companies. Instead, NASA apparently plans to pay the non-U.S. companies with U.S. taxpayer dollars.

Q4a. Is that accurate—will American taxpayer dollars be used to pay non-U.S. companies for their participation in the CEV project?

Q4b. If so, what is the rationale?

A4a,b. One of the goals of the *Vision for Space Exploration* is to promote commercial and international participation in exploration to further U.S. scientific, security, and economic interests. Exploration Systems is committed to fulfilling the Vision in an expeditious and cost-effective manner. The scope of international participation in the Vision is still being defined. In the areas of advanced concepts and technologies, Exploration Systems Mission Directorate (ESMD) has pursued ways of procuring foreign capabilities and expertise in areas where domestic sources are either unobtainable or the foreign sources reduce risks to the development of ESMD systems. As such, ESMD has been open to teaming arrangements between domestic and foreign vendors who, by linking their capabilities, are able to provide a better product for the American taxpayer than separate efforts would otherwise yield.

Additionally, ESMD has been open to teaming arrangements between U.S. and foreign companies on the Crew Exploration Vehicle (CEV) Request for Proposal where U.S. capabilities are optimized by the foreign capability. NASA has not sought cost-sharing arrangements at this time for such potential teaming arrangements in order to ensure an even competitive environment for U.S. industry.

NASA has not excluded the possibility of seeking cost-sharing arrangements in the future, so long as such arrangements do not introduce undo complications to the industry-to-industry relationship, result in an unfair competitive advantage to one industry team, or place foreign government support on the critical path for the CEV.

Q5. When John Young, the highly decorated astronaut, finally retired from NASA at the end of the year, he gave an interview on December 17th in which he was asked about whether NASA's safety culture had changed in the two years since the Columbia *accident. He said, "I was in the astronaut office the other day and I asked them how many people thought NASA had changed its culture and nobody raised their hand. There were about a hundred people there, so that's how they feel now."*

Q5a. That is a very troubling assessment from people inside the agency who are in a position to know. Would you care to comment?

A5a. The *Columbia* Accident Investigation Board (CAIB) report indicated that positive change to the NASA safety culture would be difficult to accomplish. Nevertheless, in the year and a half since the CAIB released its Final Report, NASA has significantly strengthened its safety organizations and culture. Following the CAIB's recommendations, we have established an Independent Technical Authority that operates as the warrant holder for all Space Shuttle waivers, deviations, and exceptions and acts as an independent check on engineering issues. We have created a NASA Engineering and Safety Center to act as a source of engineering expertise that is not tied to any one particular program and can be called upon to provide in-depth and independent analysis of complex technical issues. We have enlisted the services of Behavioral Science Technology, Inc. (BST), an industry leader in behavior-based performance improvement, to identify specific cultural and communications issue throughout the Agency and help develop mitigation strategies to resolve those issues. We are in the process of an Agency-wide organizational transformation that has as one of its goals the elimination of communication barriers that can pose risks to safety.

All of these changes are designed to enhance the ability of individuals to voice their opinions without fear of retribution or marginalization. The results of recent BST cultural surveys across NASA suggest that we have made some significant progress, in a very short period of time, in opening up communications between line operators and managers. Such improvements will have a positive impact on NASA's overall safety culture. The job is never done, and changes to culture tend to take a long period of time, but we feel that we have made a very positive start.

Q5b. How confident are you that the safety culture will be strong enough at the time the Shuttle is scheduled to return-to-flight? On what do you base that conclusion?

A5b. The ultimate strength of a safety culture is evidenced in the ability of individuals working throughout the organization to elevate concerns to the appropriate level of management and be confident that those concerns will be thoroughly vetted. We believe that there is ample evidence of such a strong safety culture in the Space Shuttle program supporting Return-to-Flight. For example, we have pushed back the Return-to-Flight date on several occasions so as to give ample time to fully meet all of the CAIB recommendations and Space Shuttle program-initiated activities. The Space Shuttle program is sharing our lessons learned, issues, options and ultimate decisions on how to proceed with implementation of Return-to-Flight activities by fully documenting them in the *Implementation Plan for Space Shuttle Return-to-Flight and Beyond,* which is now in its ninth revision. A key aspect of preparing for the upcoming mission has been a series of simulations where the Mission Management Team is presented with a variety of problems that could arise during a mission, and must investigate the problem and determine how to proceed. This is one example of opportunities for our Space Shuttle team to practice the types of behaviors we are stressing in our culture change activities, including understanding and assessing minority opinions. The Mission Management Team simulations have included external observers who provide feedback to the team. The Return-to-Flight Task Group, an advisory committee co-chaired by Richard Covey and Thomas Stafford, provides an independent check on—and an unprecedented level of external scrutiny of—NASA's implementation of the CAIB recommendations. There are multiple, independent avenues for safety concerns to be elevated to senior program managers, and all of those avenues have been fully exercised over the past two years. We are confident that our safety culture is significantly stronger than it once was and that, while space flight can never be without risk, the safety culture is fully ready to support the Shuttle's return-to-flight.

Q6. NASA has canceled funding for a Hubble servicing mission in the FY 2006 budget.

Q6a. What will happen to the civil servant and contractor workforce involved with Hubble servicing, and when?

A6a. The Administrator plans to review the possibility of conducting a Shuttle servicing mission to the Hubble once the Shuttle has returned to flight. Any final determination regarding the fate of the civil and contractor workforce associated with Hubble servicing must await the conclusion of that review.

Q6b. If Congress or a new NASA Administrator decides to reinstate a Shuttle servicing mission to Hubble, what civil service and contractor workforce will be required to complete the mission within the required timetable?

A6b. On the Hubble program side, the workforce involved with ongoing operations, life extension, and de-orbit activity is essentially the same workforce that would be required to support a Shuttle servicing mission. Space Shuttle workforce requirements are relatively insensitive to the mission.

Q6c. Does NASA have that workforce in place now?

A6c. Yes, NASA has that workforce in place now.

Q6d. What additional funding would be required in FY05 and FY06 to cover the non-Shuttle-related costs of a Shuttle servicing mission to Hubble?

A6d. The Administrator plans to review the possibility of conducting a Shuttle servicing mission to the Hubble once the Shuttle has returned to flight. Any final determination regarding funding for Hubble servicing must await the conclusion of that review.

Q7. Your testimony indicates that you have established "core competencies" at each of the NASA Centers that "must be maintained in order for the Agency's mission to be achieved." You also say that these competencies will be funded through competition for work. What specifically are you going to do to retain the core competencies in a particular area at any given Center over those periods when there is insufficient project funding to cover the workforce and facility costs?

A7. We are currently engaged in a process to assess the health of all NASA Core Competencies, a process that will be repeated on an annual basis in conjunction with the budget development. As part of this assessment, we may use peer reviews, external awards, patents, and benchmarking to validate that NASA's core competencies remain competitive. Our core competencies sustainment strategy focuses on competition as the preferred approach for bringing to a Center the necessary level of work to sustain a core competency. However, this strategy further provides for alternative sustainment approaches when, for example, a gap in competition opportunities puts a core competency at risk. The Centers will be responsible for identifying where they are unable to sustain the critical level from the resources available to them. Mission Directorates will then be responsible for providing needed resources through direct work assignments to the Center if necessary. If that is not feasible, the Mission Directorates are then responsible for bringing the issue forward to the Agency leadership where a tailored investment strategy will be developed.

Q8. Please provide both the actual civil service and the actual contractor workforce levels broken down by Center (including HQ) for the years FY 2004 and 2005, and also the projected civil service and contractor workforce levels broken down by Center (including HQ) that are assumed in the FY 2006 budget request for each of the years FY 2006 through FY 2010.

Q8a. How many of the current civil service employees does the FY 2006 budget request assume will no longer work at NASA by FY 2007?

A8a. The chart below shows the NASA workforce requirements as identified by the existing Agency programs. These numbers do not reflect additional workforce that will be required as Centers are awarded additional projects currently identified in the budget for future competitions. As shown in the chart, NASA's budgeted workforce decreases by 2060 FTE from FY 2006 to FY 2007 as part of the transformation of the agency to fulfill the new Vision. There are ongoing efforts to match needed skills with funded work both at the Centers currently showing reductions and at other Centers that continue to hire. There is still a significant amount of FY 2007 programmatic money not yet assigned. There will be work available for competition as the Exploration program proceeds with its overall program definition, as well as its systems engineering and integration effort and Crew Exploration Vehicle activity. There will be work available in various competitive science areas, such as the Discovery and Mars programs. NASA's ongoing health assessment of its core competencies may result in the application of additional program resources to sustain critical workforce. It is also anticipated that Centers will pursue reimbursable work for non-NASA customers in their areas of special competence. Because of these ongoing activities, FTEs currently not supported may yet be matched with funded requirements.

NASA's performance based procurements are not managed or budgeted by contractor head count, so accurate projections of the contractor workforce are not possible.

NASA	FY 2004 to FY 2010 Civil Service FTE's						
	FY 2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
Johnson Space Center	2994	3,234	3,270	3,224	3,212	3,164	3,135
Kennedy Space Center	1867	2,125	2,144	2,134	2,114	2,084	2,074
Marshall Space Flight Center	2699	2,657	2,509	2,044	2,170	2,215	2,212
Stennis Space Center	294	311	280	269	266	264	263
Ames Research Center	1444	1,375	1,297	1,029	975	931	885
Dryden Flight Research Center	567	568	527	403	406	399	372
Langley Research Center	2286	2,109	2,046	1,363	1,313	1,294	1,261
Glenn Research Center	1905	1,875	1,775	1,270	1,239	1,228	1,204
Goddard Space Flight Center	3260	3,416	3,379	3,386	3,375	3,362	3,364
Headquarters	1317	1,557	1,481	1,486	1,486	1,486	1,486
NSSC	0	*	90	130	159	159	159
AGENCY TOTAL	**18,633**	**19,227**	**18,798**	**16,738**	**16,715**	**16,586**	**16,415**

*NASA Shared Service Center (NSSC) carried in HQ in FY 05

Q9. Please provide a breakdown by specialty and by Center of the number of civil servants that have been identified as "excess competencies." What were the criteria used to determine who falls into the "excess competency" category?

A9. NASA has identified those positions that do not support a funded program or project and, therefore, must be funded through Center overhead funds. These are referred to as "unfunded capacity." Some of these "unfunded capacity" positions include competencies that we know will not be needed in their current quantity to support the Agency's new Vision and those are the competencies that are currently part of our buyout activities.

NASA will maintain the workforce necessary to assure the health of the core competencies the Mission Directorates rely on. We are currently engaged in a process to assess the health of all NASA's core competencies, a process that will be repeated on an annual basis in conjunction with budget development. Our core competencies sustainment strategy focuses on competition as the preferred approach for bringing to a Center the necessary level of work to sustain a core competency. However, this strategy further provides for alternative sustainment approaches when, for example, a gap in competition opportunities puts a core competency at risk. The Centers will be responsible for identifying where they are unable to sustain the critical level from the resources available to them. Mission Directorates will be responsible for providing needed resources, or if that is not feasible, bringing the issue forward to the Agency leadership where a tailored investment strategy will be developed.

It is anticipated that Centers will pursue reimbursable work for non-NASA customers in their areas of special competence. Centers may also consider alternative management structures for more flexibility to pursue reimbursable tasks. Once this analysis is completed, NASA will be in a position to more precisely identify its excess workforce competencies.

Q10. Administrator O'Keefe testified to our Committee in February of 2004 that NASA would know whether development of a new heavy-lift rocket would be necessary to fulfill exploration mission requirements "within this next six months to a year." *A year has now passed, and NASA has still not said whether it will need to develop a heavy-lift vehicle.*

Q10a. Why did NASA miss the milestone stated by the Administrator for reaching a decision?

A10a. Because the question of heavy lift is so central to the overall execution of the *Vision for Space Exploration,* NASA has moved very carefully to ensure that all potential technical, budgetary, and policy issues are fully considered and vetted. Since Administrator O'Keefe testified before the Committee in February, 2004, there have been a number of significant developments, including the release of the Final Report of the President's Commission on Implementation of United States Space Exploration Policy, the release of a new U.S. Space Transportation Policy, and the development of an Agency-wide strategic roadmapping process. All of these developments must be carefully considered by NASA in the decision process on the need for a heavy-lift vehicle.

NASA has made significant progress in coming to an informed decision on the potential role of heavy lift within a mixed launch vehicle fleet. Among the issues and trades that NASA is considering are the technologies from which a heavy lift vehicle might evolve (Shuttle, expendable launch vehicle, or hybrid), the needs of the International Space Station in the post-Shuttle environment, potential synergy between the needs of the ISS and future exploration requirements, and overall cost and schedule impacts. Assessments and recommendations from this ongoing evaluation are also being coordinated with other Federal Government partners, including the Department of Defense, as directed by the new transportation policy.

Q10b. When will NASA know?

A10b. We expect to have initial results from our roadmapping activity complete in May of this year.

Q10c. What are the specific criteria that will be used in making the decision?

A10c. The criteria in making the decision of whether to pursue, and if so how best to pursue, an evolved heavy lift option will include overall best value to NASA across all present and future missions, total life cycle costs, the availability of technology options and the cost/risk associated with these options (including the unique consideration of human rated/high value payloads), and the potential availability of an evolved heavy lift option against our need date.

Q10d. Is there funding reserved for such a launch vehicle in the five-year runout of the FY06 budget and if so, how much and in what account?

A10d. No, although long-range budget planning for Constellation systems does include some provisions for a heavy lift option. However, these plans do not include heavy lift funding as a separate line item in the current five-year runout.

Q11. In 2001, NASA and the Department of Defense entered into a collaborative National Aerospace Initiative (NAI). Hypersonics research to enable both near-term and longer-term advances in air-breathing hypersonics vehicles was considered to be an essential element of that Initiative. However, NASA's FY 2006 budget request contains no funding for hypersonics research. What is the reason for not providing funding—is it budgetary or is there a policy rationale for the elimination of the funding? If the latter, what is that rationale?

A11. Through a Congressional special interest item, NASA is currently funded to work on the X–43C concept in FY 2005. At present, there is no plan to continue funding hypersonics beyond the present year. In FY 2006 and the near-term, NASA will refocus its resources for the Vehicle Systems Program on a limited number of demonstrations. The current four programmatic priorities are supersonic low-boom demonstration, a demonstration of a zero-emissions vehicle, a demonstration of high altitude long-endurance aircraft, and a demonstration of integrated subsonic noise reduction. Hypersonics demonstrations may re-emerge as a high priority in the out years.

Q12. When the White House directed NASA to cut its four-year budget plan (FY 2006–09) by $2.5 billion relative to the budget plan that accompanied the FY05 NASA budget request, the aeronautics program had to absorb almost a third of that total cut.

Q12a. What was the rationale for allocating that fraction of the cut to aeronautics?

Q12b. Who proposed that allocation of the cut—NASA or OMB?

A12a,b. NASA budget formulation was guided by the Exploration Vision and other national priorities. Accordingly, resource decisions resulted in reductions between the FY 2005 and FY 2006 budget requests, which required all Directorates to contribute to deficit reduction. Throughout this process, NASA priorities and key milestones were retained.

NASA is transforming its Aeronautics program in the FY 2006 Budget request. NASA is simultaneously transforming its Aeronautics Research investment to more sharply focus on revolutionary, high-risk, "barrier breaking" technologies. Toward this end, the NASA Aeronautics Vehicle Systems Program (VSP) has been refocused away from evolutionary research and technology development of the past and toward more revolutionary, "barrier-breaking" technology demonstration projects that address critical public needs related to reduction of aircraft noise and emissions, and enable new science missions. The revolutionary technologies developed by NASA within the next decade will form the basis for a new generation of environmentally friendly aircraft and will enhance U.S. competitiveness 20 years from now. This budget supports NASA's emphasis to address basic aeronautical barriers confronting our national aviation system and supports research to pioneer and validate high-value technologies that enable new exploration and discovery, and improve the quality of life though practical applications. The President's FY 2006 Budget fully supports the Aeronautics program's vital research in Aviation Safety and Security and Airspace Systems.

Q13. Although the NASA Administrator, among others, had showcased the Jupiter Icy Moons Orbiter (JIMO) mission as the first flight demonstration of the exploration initiative's Project Prometheus nuclear technology program, NASA has now indefinitely deferred the JIMO mission due to "concerns over costs and technical complexity.. . ." What were the specific cost and technical issues, and when did they emerge?

A13. During the course of conceptual design and trade studies, it was determined that the mission requirements directly related to JIMO (such as mission lifetime to reach Jupiter) were too complex for a first mission to use space nuclear electric power and propulsion. These nuclear electric power and propulsion technologies will include a new capability to enter into orbit around multiple moons of the outer planets for long duration exploration and reconnaissance. Electric propulsion technology developed and flown in the past, and terrestrial nuclear power system development efforts both provide firm foundations upon which to build; but in both cases a flight system would require substantial technology maturation including life testing. Although NASA never prepared a formal cost estimate, a CBO estimate prepared in September 2004 indicated a cost of roughly $10 billion.

In addition, the JIMO mission concept was developed before the announcement of the President's *Vision for Space Exploration.* As a result of NASA's new direction, the needs for and uses of nuclear power and propulsion have to be reassessed. NASA is currently reviewing an Analysis of Alternatives as well as undertaking a strategic roadmapping process to better integrate nuclear technology development with the Vision and determine a more suitable and affordable, first flight demonstration mission.

Questions submitted by Representative Mark Udall

Q1. Please provide the risk assessment of the SM–4 Shuttle servicing mission that was prepared for Administrator O'Keefe, as well as any other safety analyses used by the Administrator in making his determination to cancel the SM–4 servicing mission.

A1. Attached is a letter provided to Chairman Sherwood Boehlert on March 14, 2005, that responds to your question. *[See p. 71.]*

The decision not to pursue a Shuttle servicing mission to the Hubble was based on a relative risk analysis and operational complexity. The National Academy of Sciences (NAS) report recommended a Shuttle-based servicing mission for Hubble, and concluded that a Shuttle flight to Hubble was not significantly more risky than a Shuttle flight to the International Space Station (ISS). Yet while all space flight is inherently risky, there are both on-orbit and ground processing requirements that would be notably unique to a Hubble servicing mission. While similar issues (thermal protection system inspection and repair, contingency Shuttle crew support, and potentially rescue) exist for missions to the ISS, they can be mitigated more easily, in part due to the increased time available for understanding and responding to an emergency situation at the Station. For a Hubble servicing mission, the options and available time for dealing with an on-orbit emergency are greatly reduced, posing additional risk to the mission.

NASA has developed a five-point flight rationale (addressing safety requirements) for Space Shuttle RTF, which is grounded in the recommendations of the CAIB and predicated on primary hazard control, warning devices and special procedures. The first two elements of that flight rationale (*Elimination of Critical Debris* and *Impact*

Detection During Ascent) rely upon Space Shuttle hardware, infrastructure, and procedural improvements that broadly apply to all missions, including those to destinations other than the International Space Station (ISS). However, the efforts of the Space Shuttle program to meet the three remaining elements of the RTF flight rationale (*On-Orbit Debris Impact/Damage Detection; On-Orbit Thermal Protection System Repair;* and, *Crew Rescue)* assume access to the resources of the ISS. Developing the additional capabilities necessary to meet these three elements of the flight rationale for a Hubble servicing mission would entail additional risks above and beyond those inherent in a mission to the ISS.

The ISS provides Space Shuttle managers with three critical capabilities not found in autonomous missions. First, the ISS serves as an independent observing platform for assessing the integrity of the Space Shuttle's Thermal Protection System (TPS). Second, the ISS can operate as an independent working platform from which Space Shuttle crews can conduct repairs to the TPS if necessary. Finally, the ISS provides redundancy as a safe haven platform capable of sustaining a stranded Space Shuttle crew for a significantly longer period of time than the Shuttle alone can.

To apply this same flight rationale to a Hubble servicing mission, NASA would have to develop new capabilities that are analogous to those provided by the ISS. The Orbiter Boom Sensor System would have to be extensively modified, or an alternative capability would need to be created. Specifically, there would have to be new hardware and procedures to provide space-walking astronauts a platform from which to effect repairs to a damaged TIPS, without increasing the risk of further damaging the Orbiter. Additionally, a way would need to be found to sustain the crew of a hopelessly crippled Orbiter with limited life-support capabilities long enough for a second Shuttle to be launched on a rescue mission. That rescue mission, in turn, would need to be processed at the same time as the Hubble servicing mission itself, a situation which would be highly complex, would require double the normal workload on ground launch and processing teams, and would put an unprecedented strain on the overall Shuttle system. Finally, a rescue mission would require many unproven techniques, such as emergency free-space crew transfer in space suits while performing Space Shuttle to Space Shuttle station-keeping. Being based at the ISS offers the advantages of multiple hatches, airlocks, and established docking and evacuation procedures, which would afford a shirt-sleeve, nominal transfer of crew from the ISS to the rescue Orbiter.

New capabilities would need to be built, tested, and validated before Hubble had degraded to the point where any reasonable repair effort would be impossible. Seeking to develop and validate these new capabilities in time for Hubble servicing, as well as process a second launch, is contrary to the milestone-driven approach NASA has adopted in response to the CAIB recommendations.

Based on analysis of the relative risks, operational complexity and implicit schedule pressure, in February 2004, NASA decided not to proceed with a Shuttle servicing mission of Hubble. The new NASA Administrator has stated his intention to revisit this earlier decision in light of what NASA learns after the Shuttle returns to flight.

Q2. Please provide NASA's cost estimate for the SM–4 Shuttle servicing mission to Hubble, including a breakdown of it by cost category and the specific assumptions included in the cost estimate.

A2. NASA estimates the cost of $1.7 billion–$2.4 billion for SM–4—a Space Shuttle servicing mission to Hubble. This estimate was provided to Aerospace Corporation to assist them in their development of an Analysis of Alternatives (AOA) for the Hubble Space Telescope. For Space Shuttle missions, the general assumption of five years of operations was made. The AOA report provided by Aerospace Corporation adjusted that estimate slightly by reducing two years of operations for the SM–4 mission. Aerospace made this adjustment based on their own assessments of operations costs, therefore reducing the Space Shuttle numbers by two years of operations (worth about $200 million) in order to provide a baseline for comparison. The estimates provided are considered preliminary only. Additional assumptions included three years of Hubble operations after servicing is completed.

These costs assume completion of required Return-To-Flight (RTF) actions for the Space Shuttle fleet and missions to ISS, but RTF costs are not included in the $2.4 billion estimate.

The $2.4 billion includes a small portion of the cost to cover the de-orbit.

NASA's estimate is as follows: (dollars in millions)

Sustaining engineering for Hubble (to support servicing)	457
Delay in de-orbit mission (cost of extension, to be added to baseline cost for de-orbit)	40
Extension of Hubble operations to 2012	117
Shuttle services unique to servicing mission and extravehicular activity	33
Payload processing	43
Autonomous inspection and repair capability	260 – 300
Autonomous rescue mission capability	293 – 338
Rescue mission unique requirements and ground ops	22
ISS program impact (3-month delay)	13
Delay in Shuttle phase out (3 months)	401 - 1,078
TOTAL ESTIMATE FOR SM-4 MISSION	**1.7- 2.4 billion**

Q3a. NASA has not committed to providing a "safe haven" capability for the Space Shuttle at the International Space Station (ISS) beyond the first two Shuttle flights after Return-to-Flight. Does NASA intend to baseline such a requirement for the duration of the ISS assembly phase (running through 2010)? If not, why not?

A3a. NASA has not specifically ruled out the requirement to have a safe haven capability for an extended period. We are using safe haven as a last resort in the unlikely event that return-to-flight modifications are in error and there is a need to safely bring the crew home on another vehicle or vehicles.

Q3b. What specifically would be required to enable a "safe haven" on the ISS for a combined crew of 9–13 Shuttle/ISS astronauts for 30–90 days for the duration of the Space Station assembly phase? What changes to NASA's current ISS assembly and operations plans would be required?

A3b. By far, the greatest issue with maintaining a safe haven capability through 2010 is the adverse impact it would have on logistics needs and the upmass impact to the ISS to maintain the capability to support the larger crew. The Space Shuttle and International Space Station programs are currently assessing the logistics requirements needed to support the safe haven capability beyond the first two Return-to-Flight missions.

Q3c. If NASA decides not to baseline a "safe haven" capability on the ISS for the duration of the ISS assembly phase, will NASA baseline a requirement for a backup Shuttle on the launch pad for all remaining ISS assembly flights?

A3c. The current safe haven approach does not require a backup Shuttle to be on the launch pad at the time of launch. For STS–114, the launch-on-need vehicle will not have rolled out of the Orbiter Processing Facility, given that we launch at the opening of the window on May 15, 2005. The requirement is to have a backup Shuttle in position to launch in sufficient time to meet the defined safe haven support window that the ISS offers the combined Shuttle/ISS crew. The requirement and timetable for the launch-on-need vehicle in support of STS–121 is similar to that for STS–114. The Space Shuttle program is currently assessing the launch-on-need requirement for missions after STS–121.

Q4. NASA is significantly reducing its participation in a number of national interagency R&D initiatives in its FY06 budget request, most notably the Nanotechnology, Networking and Information Technology, and Climate Change Science initiatives. What are the specific reasons for each of the funding reductions?

A4. To pursue the *Vision for Space Exploration* in FY 2006, NASA must assemble a much broader portfolio of research than in past years. Nanotechnology and National Information Technology Research and Development (NITRD) were previously primary focus areas. NASA's transformation to the Vision has a much more focused research agenda than in previous years. At the same time, the funding available to support this broader research portfolio remains roughly unchanged. As a result,

fewer projects in Nanotechnology and NITRD are competitively selected than in previous years.

In 2006, NASA's *Vision for Space Exploration* and mission needs for Return-to-Flight will affect its participation in the National Information Technology Research and Development (NITRD) Program. NASA will continue operating the 52-teraflop *Columbia* computer acquired in 2004 and 2005 for science and engineering simulation, including providing access to this world-class resource for the scientific community. Funding for Grand Challenge Applications will be reduced, and High-End Computing (HEC) technology research will be completed, reducing its HEC I&A (Infrastructure and Applications) participation and ending NASA's HEC R&D participation. NASA will continue interagency coordination activities in architectures, testbeds, and system performance assessment. Funding for research in intelligent systems and grid computing has been redirected to more directly address time-critical agency mission needs related to Return-to-Flight and the *Vision for Space Exploration,* reducing NASA participation in Human Computer Interface and Information Management (HCI&IM) and Large Scale Networking [including Next Generation Internet] (LSN). NASA investments in autonomous systems and robotics are no longer counted as part of Software Design and Productivity (SDP), and NASA funding similarly is no longer counted as part of Social, Economic, and Workforce Implications of IT (SEW). As a result of these reductions and redirections, NASA overall funding for NITRD activities changes from $162.9 million in FY 2005 to $74.3 million in FY 2006.

NASA continues its contribution of over $1 billion annually to improving our understanding of our Earth's climate. NASA's constellation of over 28 Earth-Sun observing satellites provides a host of on-going data sources to improve our understanding of Earth's climate. NASA is helping to protect this scientific resource by providing funding for extended operations of many satellites beyond their initial design life. Additional funding is provided in FY 2006 to complete several key missions in development, including Calipso, Cloudsat, NPOESS Preparatory Project (NPP), and Ocean Surface Topography Mission (OSTM). Additional missions in the formulation stage, if they are approved to proceed to development, will provide new ways to assess the Earth's climate. The percent reduction in CCSP elements of the FY 2006 budget reflects a decrease in mission operations funding due to several missions reaching the end of their operational life and decreased ground network expenditures, along with a planned ramp-down in spending on NPP, which is nearing launch. The FY06 request also assumes the Glory mission will be an instrument-only build.

NASA continues to make a strong investment in nanotechnology, and will invite proposals for nanotechnology development in future responses to Broad Agency Announcements. In addition, NASA has had discussions with the National Science Foundation concerning strategic partnership in various areas of research and technology, including nanotechnology.

Q5. Jupiter's moon Europa ranked very high on the National Academies' solar system decadal survey priority list. Since the FY06 budget effectively cancels—"indefinitely defers" to use OMB's language—the Jupiter Icy Moons Orbiter (JIMO) project,

Q5a. Are there any plans for an alternative mission to Europa within the next decade?

Q5b. If so, where will the funding for it come from?

A5a,b. NASA is studying alternative ways to get to Europa. In addition, we have opened a dialogue with our international partners, particularly the Europeans, regarding this issue. No funding source has yet been identified for such alternatives.

Q6. NASA has for years touted the Space Station's research program as benefiting the health and welfare of citizens back here on Earth. Now as part of the restructuring of the ISS research program, NASA has indicated that it will only focus on exploration-related R&D and will largely abandon any research directed at terrestrial applications.

Q6a. What is the reason for eliminating essentially all non-exploration-related research on the Station? Why can't it co-exist with the exploration-related research program?

A6a. NASA is in the process of realigning its research initiatives in order to support the *Vision for Space Exploration.* Efforts will be focused on research that directly supports the future safety and effectiveness of Expedition crews. NASA's efforts in the biomedical area are focused on research that will result in a significant reduc-

tion of risk to exploration crews. A curtailment of alternate research within our portfolio is necessary due to space-based resource limitations.

The Exploration Systems Mission Directorate (ESMD) recently conducted a Zero Base Review of the entire Human Systems Research and Technology (HSRT) portfolio which consists of the programs and projects of the former Biological and Physical Research Enterprise. This review has identified the following research priorities for successful implementation of the Vision: space radiation health and shielding, advanced environment control and monitoring, advanced EVA, human health and countermeasures, advanced life support, exploration medical care, and space human factors and behavioral health. One of the conclusions reached during the Zero-Base Review suggested that NASA's research programs should prioritize medical research on human subjects over basic animal, cell, and tissue models. The redirection of the program in this way was based on an internal programmatic review and assessment, input from NASA's Medical Policy Board Subcommittee on the Centrifuge Accommodation Module and Centrifuge, and recommendations from the National Academies/Space Studies Board (NA/SSB) report: *"Assessment of the Directions in Microgravity and Physical Sciences Research at NASA."*

The HSRT Zero Base Review has been completed and results are being reviewed and integrated.

Concurrent to the Zero Base Review activity, NASA is conducting an ISS utilization effort to identify the best means by which to use the unique ISS platform. Based on the results of the Strategy-to-Task-to-Technology (STT) prioritization process currently in work, such utilization opportunities may include flight experiments to test and validate technologies like in-space assembly, cryo fluid management, advanced propulsion, and space power systems. NASA is also investigating how efficiencies can be gained in the area of payload planning, integration of research hardware into the launch vehicle and the ISS, crew training, and real-time operations support.

Additionally, NASA continues to expand its contribution to Earth applications of our research technology development investments through the Innovative Partnerships Program (IPP). IPP is taking deliberate actions to improve the quality of life on Earth from these investments, through its current projects, technology transfer, Small Business Innovative Research (SBIR), Small Business Technology Transfer (STTR), Industry-led partnerships and University-Led partnerships, all fostering the creation of benefits throughout all NASA research and technology development programs. University-led partnerships include the Research Partnerships Centers (RPCs), an established network of dual-use research centers located at universities around the U.S., and the University Research Engineering Technology Institutes (URETI), a consortia of universities pursuing basic research in nano-technology. Highly leveraged partnerships such as the RPCs make it possible to meet NASA's exploration needs while at the same time fostering the creation and delivery of Earth benefits through the industrial partners. The leveraging of these partnerships helps to make the exploration vision affordable, while the benefits help to make it sustainable.

Q6b. What are you telling all of the researchers who based their career plans on NASA's commitment to support such fundamental and applied microgravity research?

A6b. NASA is moving to the next step to implement the knowledge gathered by the research community on gravity-driven phenomena in biological and physical systems, and we will need the research community's further participation in solving more focused, but no less challenging problems. The scope of NASA's support to science and technology may need to increase as our efforts in space exploration become more substantial in the coming years. New areas of emphasis will provide opportunities for participants in the previous fundamental and applied microgravity research program to contribute to solving problems and advancing technologies in areas like in-situ resource utilization for life support and spacecraft propellants, in-space multi-phase fluid processes for propulsion and power generation, low-gravity processes for fabrication and repair, innovative technologies for medical and environmental monitoring sensors and integrated control systems, and a variety of advanced materials solutions needed for radiation protection. The opportunities for contribution from this community have not decreased—they have become more focused on space exploration.

Q7. The last round of Discovery proposals (11) yielded only a "Mission of Opportunity" (the Moon Mineralogy Mapper instrument for the Indian Chandrayaan 1 mission) and not a full mission. What will happen to the remaining funds?

Will they be maintained within the Discovery program such that there may be funding for two missions in the next round (12)?

A7. The remaining funds will stay within the Discovery Program. The surplus early year funding will primarily be used to solve funding problems with Deep Impact, Stardust, and Kepler. Funding from about FY 2007 onward will go toward a potential second selection in the next AO. A second mission will only be selected if it is qualified, and if the proposed funding can be phased such that it is affordable within the current (combined Discovery-11 and -12) budget profile. It is anticipated that this will indeed be the case. In the interim, NASA has assembled a review team to assess our recent decisions on the Discovery Program. NASA expects the results of this review in the coming weeks.

Q8a. The Deep Space Network (DSN) is receiving a slight decrease from last year's budget. Your budget materials acknowledge that the DSN infrastructure is starting to show its age and repairs and upgrades are going to be needed. Will you have the resources you need for the approximately 35 missions the DSN will support this year and to prepare for the increasing data needs in future years?

A8a. The DSN will continue to support all current missions. The FY 2006 budget request and the FY 2005 budget are adequate to support continued operation of the DSN. Additional investments will be required in the future to support new missions, and to renew aging infrastructure. The strategy for making these investments is currently under development.

Q8b. What repairs and upgrades planned for the DSN to prepare it for the increasing data needs expected in future years will be deferred, delayed, or otherwise negatively impacted as a result of the FY 2006 budget and its five-year runout?

A8b. The Science Mission Directorate is working with the Exploration Systems Mission Directorate to develop and validate requirements and capabilities for future needs. We recognize that the DSN will need significant upgrades to satisfy these future needs and are assessing infrastructure and performing failure analyses to help determine how to focus the effort. The specific plan will be refined as part of the FY 2007 budget process.

Q8c. Please provide the seven-year (FY 2004–2010) budget plan for the Deep Space Network, broken down by category of expenditure.

A8c. The FY 2006 budget request for the Deep Space Network is shown below, by major categories.

Deep Space Network	FY04*	FY05*	FY06	FY07	FY08	FY09	FY10
Operations & Maintenance	159.7	141.1	142.2	140.2	143.6	148.1	128.3
DSMS System Engineering	5.3	10.9	11.3	12.0	12.4	12.4	13.0
Technology Improvement (Comm & Info Sys)	8.7	10.5	10.5	10.5	10.5	10.5	0.0
All Other (Program Mgt., Safety & Environmental, Program Assurance, Strategic Planning)	48.8	38.9	34.6	34.3	35.9	37.2	71.7
DSN Total FY 2006 President's Budget	**222.5**	**201.4**	**198.5**	**197.0**	**202.4**	**208.3**	**212.9**

*Represents funding level reported in the most recent Congressional Operating plan, dated December 23, 2004.

Q9. What are the specific "schedule issues" that have caused Kepler's launch to be delayed apparently indefinitely?

A9. Funding issues within the Discovery Program necessitated a reduction in the FY 2005 funding profile for Kepler. The total impact of this reduction is still in work, but it is expected to result in a six to eight months slip in the Kepler launch date. This means that Kepler would launch between June and August 2008.

Q10. GLAST is having schedule delays in part due to "withdrawal of international partners"—who are these partners, what were they responsible for and why have they withdrawn? Besides schedule, what else will this withdrawal impact?

A10. GLAST entered development at the end of 2003. The Large Area Telescope (LAT) is the primary instrument on this mission, and is being developed under a NASA contract with the Stanford Linear Accelerator Center, which is operated by Stanford University for the U.S. Government Department of Energy. The LAT Principal Investigator assembled a consortium that includes the U.S. Department of Energy and institutions in France, Germany, Japan, Italy and Sweden to develop and build this instrument.

During project formulation, the Italian Space Agency, ASI, and the French Space Agency, CNES, went through budgetary reprioritizations and withdrew from some of their GLAST LAT activities; ASI withdrew funding for the Malindi ground station in Africa, and CNES determined they could no longer provide their input to the LAT. The Italians, however, have continued to provide the remainder of their planned contribution (a portion of the LAT silicon strip detectors, the majority of the LAT tracker production costs, and science support). The French (CNRS/IN2P3 and CEA/DSM) are providing science support, as well, and CNRS/IN2P3 continues to supply the calorimeter structures.

Prior to the aforementioned changes, GLAST had a working launch target of September 2006. At the time of Confirmation Review (December 2003), the baseline schedule launch of May 2007 and the life cycle cost of $739.5 million (as reported in the FY 2005 NASA budget request), reflected the impact of these two changes in international participation.

Questions submitted by Representative Michael M. Honda

Q1. There has been a reorganization at NASA HQ in order to better address the Exploration requirements. What is the impact of this on existing contracts, including research contracts and cooperative agreements? Will NASA fully honor its existing commitments to the University of California and San Jose State University?

A1. In 2004, NASA merged the former Space and Earth Science Enterprises into a single Science Mission Directorate with three themes: The Universe, Solar System Exploration, and Earth-Sun Systems. The science transformation also brought together similar needs/processes for engaging the external scientific community in planning/sponsoring scientific research, mission solicitation/selection/management, advanced technology development, and business management.

The research and technology development activities of the former Exploration Systems Enterprise and former Biological and Physical Research Enterprise have been merged and are now both managed in the Exploration Systems Mission Directorate (ESMD). Organized in this way, ESMD will be able to fully integrate the critical human system element with the broad engineering systems infrastructure required for the human exploration of the Solar System. This full integration enables the early insertion of critical human support requirements to implement safety, sustainability, and exploration crew effectiveness.

The Science Mission Directorate does not plan to terminate any research investigations as a result of reorganization at NASA Headquarters—on the contrary, the resulting efficiency improvements and science coordination will most likely allow SMD to provide additional science opportunities. In particular, all current commitments from the Science, Exploration Systems, and Education Mission Directorates to the University of California and San Jose State University will be honored.

Q2. With mission complexity and duration increasing, the challenges of autonomy and software dependability appear to be more important than before. What is NASA doing to address these technical challenges where it has such aggressive requirements?

A2. NASA has been proactive in addressing software related issues for increased mission complexity and duration. The Agency is taking a multi-faceted approach to assure software-supporting NASA missions will meet the technical challenges associated with an aggressive set of requirements. Highlights of the Agency's approach include:

a) In the final quarter of 2004, NASA issued a new set of procedural requirements (NPR 7150.2, Software Engineering Requirements) and significantly updated two NASA standards (NASA–STD–8739.8, NASA Software Assurance Standard, and NASA–STD–8719.13, Software Safety Standard).

b) The NASA Independent Verification and Validation (IV&V) Facility is the Agency's agent for the development and application of independent verification and validation processes and technology to improve reliability

and reduce risk in software systems. The NASA IV&V Facility, located in Fairmont, West Virginia, has been performing verification and validation on mission critical software across the Agency's missions and projects for over 10 years.

c) In January 2005, the NASA Chief Engineer issued a Technical Warrant for the discipline of software engineering. The goal of the NASA Technical Warrant system is to establish and execute a standard, formal process for delegating technical authority from the Chief Engineer to competent experienced individuals conducting and overseeing high-risk technical work in order to assure safe and reliable operations and missions.

d) NASA has funded research to improve the dependability of software intensive systems. Two of these programs of note are the High-Dependability Computing Program (HDCP) and the Software Assurance Research Program (SARP).

e) NASA has an ongoing commitment to the NASA Software Engineering Initiative Implementation Plan established in January 2002. This initiative defines a NASA-wide comprehensive approach for improving software engineering to a quantifiable maturity level commensurate with mission criticality in order to meet the software challenges of missions and projects. This initiative employs the common frameworks of the Software-Capability Maturity Model (SW–CMM) and the CMM Integrated (CMMI) developed under the auspices of the Software Engineering Institute at Carnegie Mellon University.

f) The NASA Engineering Training program provides Agency-wide training to advance software engineering skills and assure critical personnel are properly trained in this discipline.

g) The NASA Engineering and Safety Center (NESC) at Langley Research Center maintains a Software Super Problem Resolution Team to coordinate and conduct robust, independent engineering and safety assessments across the Agency.

Q3. The Vision for Space Exploration *is clearly a long-term goal. To accomplish such a long-term goal will take long-term stability and excellence within the Agency's technical infrastructure. Yet management is diverting much of its funds to meet short-term goals while sacrificing critical in-house core competencies and science. The* Columbia *Accident Investigation Board warned that excessive downsizing of the in-house technical competence contributed to the* Columbia *disaster, but NASA is accelerating this process rather than reversing it. How is NASA incorporating this lesson-learned from the Shuttle loss into its workforce plan?*

A3. NASA is taking a deliberate, thoughtful and targeted approach to realigning its workforce to meet the Exploration Vision. This means that the competencies needed to accomplish its current and expected future work are being identified through an analysis of NASA's core organizational and workforce competencies. NASA's workforce will be realigned in a manner that ensures retention of needed competencies and avoids any skill gaps that may impact the success and safety of future missions. NASA's field centers are fully engaged in this review of the Agency's competency needs. Their assessments are a critical part of the decision process and key to the short- and long-term stability of the Agency.

Q4. I would like to draw your attention to a table on page SD 5–1 of the budget materials your agency supplied to Congress. This table shows Civil Service Distribution of Full Time Equivalent employees at the Centers. I will focus on Ames Research Center in particular, since it is adjacent to my district. The table shows what can best be described as simple attrition-type decreases in FTEs. However, on February 7th, Ames' Center director announced to his entire staff that the FY 2006 budget would require, among other things, a reduction of about 400 Civil Service employees and an equal number of on-site contractors over the next year and a half. Similar draconian announcements have been made by Glenn and Langley's Center directors. Please tell me where do the numbers come from in your glossy notebook? And why is NASA telling Congress something so vastly different from what the employees at the Centers are being told?

A4. The FTE levels on page SD 5–1 represent the NASA workforce only through FY 2006 and do not show the workforce currently budgeted for funded programs from FY 2007 to FY 2010. The chart below shows the complete workforce runout through 2010 and shows the 400 FTE reduction in the level of the workforce currently budgeted for funded programs through FY 2010 at Ames Research Center.

Similar situations exist at Glenn and Langley Research Centers. To a degree, these lower budgeted workforce levels reflect the fact that we are still engaged in an assessment of the workforce required to fulfill the *Vision for Space Exploration.*

We are matching needed skills with funded work both at the Centers currently showing reductions and at other Centers that continue to hire. There is a lot of programmatic funding in the budget runout that is not yet assigned to a particular center, contractor, or research institution. Billions of dollars of work will be available for competition as the Exploration program proceeds with its overall program definition, as well as its systems engineering and integration effort and Crew Exploration Vehicle activity. There will be work available in various competitive science areas, such as the Discovery and Mars programs.

We are currently assessing the health of NASA's core competencies required to support the Vision, a process that will be repeated on an annual basis in conjunction with the budget development. Our core competency sustaining strategy focuses on competition as the preferred approach for bringing to a Center the necessary level of work to sustain a core competency. However, this strategy further provides for alternative sustaining approaches when, for example, a gap in competition opportunities puts a core competency at risk. The Centers will be responsible for identifying where they are unable to sustain the critical level from the resources available to them. Mission Directorates will be responsible for providing needed resources, or if that is not feasible, bringing the issue forward to the Agency leadership where a tailored investment strategy will be developed.

In addition to work associated with the Vision, it is anticipated that Centers will pursue reimbursable work for non-NASA customers in their areas of special competence. In this regard, Centers may consider alternative management structures for more flexibility to pursue reimbursable tasks.

As a result of these activities, the workforce levels in the budget runout will increase to the extent additional FTE are needed to support identified and funded program requirements.

NASA	FY 2004 to FY 2010 Civil Service FTE's						
	FY 2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
Johnson Space Center	2994	3,234	3,270	3,224	3,212	3,164	3,135
Kennedy Space Center	1867	2,125	2,144	2,134	2,114	2,084	2,074
Marshall Space Flight Center	2699	2,657	2,509	2,044	2,170	2,215	2,212
Stennis Space Center	294	311	280	269	266	264	263
Ames Research Center	1444	1,375	1,297	1,029	975	931	885
Dryden Flight Research Center	567	568	527	403	406	399	372
Langley Research Center	2286	2,109	2,046	1,363	1,313	1,294	1,261
Glenn Research Center	1905	1,875	1,775	1,270	1,239	1,228	1,204
Goddard Space Flight Center	3260	3,416	3,379	3,386	3,375	3,362	3,364
Headquarters	1317	1,557	1,481	1,486	1,486	1,486	1,486
NSSC	0	*	90	130	159	159	159
AGENCY TOTAL	**18,633**	**19,227**	**18,798**	**16,738**	**16,715**	**16,586**	**16,415**

*NASA Shared Service Center (NSSC) carried in HQ in FY 05

Q5. I have got some questions about the way in which you are introducing a competitive paradigm to the NASA. It appears that in-house Civil Service employees are marginalized or excluded by chaotic, rushed, and unprofessional proposal and review processes and by outsourcing quotas. Can you comment on the procedures that have been used for both intramural and extramural calls for proposals by ESMD, on the shorter timelines provided for intramural proposers, and on the pre-determined allocation of greater funds for external calls for proposals than internal calls?

A5. New space technology developments are critical to the success of the *Vision for Space Exploration.* However, to have an impact, these new developments must be properly focused on the most important technical challenges that face NASA in realizing a long-term program of exploration that is sustainable and affordable.

Because several of NASA's technology development efforts must be effectively and efficiently focused on exploration, a year long, multi-step process was used during FY 2004 and early FY 2005 to reformulate and refocus ongoing NASA space technology R&D programs. This reformulation process began in February 2004 with a 'zero base review' of ongoing technology projects in the former Mission and Science Measurement Technology Program, which were transferred to the Exploration Systems Mission Directorate (ESMD) from the Office of Aerospace Technology. At the same time, various studies within NASA and ESMD better defined initial objectives, schedules, requirements, and a spiral development approach for exploration in the context of the *Vision for Space Exploration.* On the basis of the Vision and the emerging requirements set, NASA established a new Exploration Systems Research and Technology theme (ESR&T) to develop the critical technologies needed for future exploration missions. The ESR&T theme includes the Advanced Space Technology Program, the Technology Maturation Program, the Innovative Partnerships Program, and the Centennial Challenges Program.

Following the creation of the ESR&T theme, a NASA-wide team was established (involving every Center and over 100 individuals) to implement program-level planning efforts. This team developed content for an ESR&T Formulation Plan, which was issued in March, 2004. The ESR&T Formulation Plan outlined the major elements of each program, identified the technical areas that would be addressed to meet exploration mission needs, and established the processes for selecting new technology development activities.

The selection process for new projects involved two separate competitions: an Intramural Call for Proposals (ICP) issued in May 2004 to select projects led by NASA Centers, and a Broad Agency Announcement (BAA) issued in July 2004 to select projects led by external organizations. Both solicitations were based on the critical technology needs identified in the ESR&T Formulation Plan. This two-part selection process was designed to encourage partnerships between the NASA Centers and external organizations, to insure that the best ideas from all organizations would be proposed without concern for intellectual property infringement, and that technology development activities would be focused on practical applications and successfully infused into NASA missions. In the ICP projects, the majority of the work is performed by NASA researchers, with participating team members from industry, universities, and other government agencies. In the BAA projects, the majority of the work is performed by external researchers, with NASA personnel participating as collaborators.

Although both ICP and BAA processes were conducted on an aggressive schedule (about 100 days in duration from release of a solicitation to announcement of awards), both efforts provided approximately two weeks for proposers to develop their one-page, non-binding Notices of Intent (NOIs), and 30 days to develop their full proposals.

Both solicitations were highly competitive. Over 1300 NOIs were submitted to the ICP, and these were evaluated for their relevance to exploration mission needs by the ESR&T management team at NASA Headquarters. Based on the relevance evaluations, 147 NASA investigators were invited to submit full proposals. The full proposals were then reviewed for technical merit, management approach, and cost by an external peer review panel, and 48 intramural projects were selected based on the peer review panel recommendations. The ICP resulted in $573 million in new project awards.

For the BAA, over 3,700 Notices of Intent were submitted. A team of reviewers from the NASA Centers evaluated the relevance of the NOIs, and 498 full proposals were invited. The full proposals were evaluated by peer review panels consisting of over 100 non-conflicted NASA and university reviewers, and 70 extramural projects were selected. The BAA resulted in an additional $1.1 billion in new project awards.

Guidelines were established for the approximate scope of work to be led by either NASA or non-NASA investigators. However, there was no 'quota' that set fixed limits on the funding that could go to intramural versus extramural projects. The actual selections were based on the competitive evaluations and the availability of funds. The NASA Centers received approximately 50 percent of available program funding, both as principal investigators on the intramural projects and as collaborators on the extramural projects. The two-part competitive selection approach using the ICP and the BAA resulted in over 250 collaborations among NASA and non-NASA investigators, which was the original intent.

The Exploration Mission Directorate is committed to enhancing all of our processes, as we evolve. Thus, based on lessons learned from the initial ICP and BAA competitions, we will be adapting our processes for future ICP and BAA competitions to ensure that we obtain the best value for the government, from all sources,

including NASA field centers, industry, and universities. Specific suggestions for improvement are always welcome.

Q6. What is going to happen if you realize in the future that some of the expert scientists and engineers that you have identified today as "excess competencies" and are eliminating (or planning to) through buy-outs and other means are actually required to accomplish the Vision and you want to hire those employees back? From what I hear about the brutal way employees and contractors are being treated right now, they are not likely to want to go to work for NASA in the future and you are likely creating future recruiting problems for the Agency among those best and brightest scientists and engineers who can expect much better treatment from academia and industry even in times of economy hardship. If it is necessary to execute Reductions in Force (RIFs), will you commit to doing this in a reasonable manner and at a responsible pace after consulting with Congress through the annual workforce plan review process? Why not require direct funding of R&D Civil Service salaries at the centers at maybe half of the current level in FY06, and ramping this down over the following couple of years to allow for an orderly and fair transition to a more competitive environment? This phase out would allow for a smooth and rational transition to Full-Cost Management, in which 1) in-house proposers can transition off of their current tasks and compete for future funding opportunities and 2) Centers can properly shed institutional burdens to reset overhead. It would seem that demanding immediate change of both proposers and Centers is unrealistic and is driving the unnecessary loss of in-house capabilities and expertise.

A6. NASA is taking a deliberate and thoughtful approach to realigning its workforce to meet the Exploration Vision. This means that the competencies needed to accomplish its current and expected future work are being identified through an analysis of NASA's core organizational and workforce competencies. NASA's workforce will be realigned in a manner that ensures retention of needed competencies and avoids any skill gaps that may impact the success and safety of future missions. The process for assessing and revisiting the health of our core competencies is addressed in the answer to Question 4. All civil service staff is funded through FY 2006 to allow us to conduct this realignment using a strategic, deliberate approach, with a reduction in force as a last resort effort that will only be considered if all of our voluntary efforts (job fairs, buy-outs) are not successful. For competitive opportunities, Centers are permitted to use overhead rates for FY 2005 and FY 2006 that exclude the additional cost burden of uncovered capacity, so the overhead rate is "reset."

Q7. How many managers and non-clerical administrative employees does NASA employ? How has this workforce sector been changing over the last four years? My reading of the numbers is that the ratio has bloated to a level of almost one administrative non-clerical employee for every two R&D employees (I believe at Ames there are about 400 non-clerical administrative employees for about 800 scientists and engineers). How do you justify that ratio for an agency with such ambitious technical goals? Any private R&D/engineering company with numbers like that would be "transforming" itself by getting rid of mid-level managers. Why isn't NASA planning a focused reduction in its management workforce?

A7. During the last four years NASA's civil servant science and engineering positions have increased from 10,957 positions to 11, 287 positions while non-clerical administrative civil servant positions have increased from 4,454 positions to 5,181 positions. The size of NASA's non-clerical administrative workforce needs to be viewed in the context of NASA's overall science and engineering workforce, which includes the contractor workforce. For example, in addition to the civil servant population, NASA employs over 25,000 on-site contractor staff and another 5,000 employees at the Jet Propulsion Laboratory. These employees are predominately involved in science and engineering work.

NASA's civil service professional/administrative workforce serve in important business management functions, such as procurement, contract administration, and financial management, that are necessary to ensure prudent stewardship of resources entrusted to the Agency.

Q8a. How much of NASA's current workforce turmoil and financial uncertainty are due to the Agency's adoption of SAP financial management software?

A8a. The current workforce turmoil and financial uncertainty are due to Transformational realignment activities, and not SAP software. In FY 2003, the Integrated Financial Management Program consolidated ten Center-based accounting

systems and approximately 200 independent sub-systems and transitioned to a single, Agency-wide accounting system. This exposed many problems with the integrity of historical data and weaknesses in financial practices and internal controls. Through the IFM Program and the Office of the CFO, NASA is in fact working to provide greater certainty and confidence in the financial data and management information it presents to its managers.

Q8b. Management policies are often changed to fit the software, rather the product fitting the agency's needs. And while this software system is something NASA brags about in its budget, because adopting it got NASA a green light, rumor has it that it has "transformed" the process of getting a purchase order from something that used to take an hour to something that can now take months. How is this helping run the Agency?

A8b. Best practice—and in fact federal guidance—for implementing Commercial Off The Shelf (COTS) information technology systems dictate changing organizational structures and business processes to fit the software, and not the reverse.

NASA is currently not rated at "green" for financial management. Nevertheless, we are proud of our achievements, especially given that the industry standard shows that less than a third of similar programs succeed.

The SAP solution requires the fiscal discipline of understanding basic finance, knowing relevant procurement information, and more importantly, having the availability of funding before obligating taxpayer dollars. Should an organization or user possess this fiscal discipline and have funding available, transaction times are minimal. This level of internal control and fiscal discipline is imperative if NASA is to be struck from the GAO's High Risk List.

Q8c. Why was SAP (a German software product) selected as opposed to Oracle (a U.S. product)?

A8c. The software selected by NASA was made in accordance with a competitive procurement process in line with Federal Acquisition Regulations. These regulations require that all federal agencies procure from approved suppliers on the U.S. General Services Administration's (GSA's) Financial Management Supply Schedule, and that any financial systems also be certified by the Joint Financial Management Improvement Program (JFMIP.) Neither the GSA nor the JFMIP have excluded non-U.S. suppliers.

Q8d. Why is JPL not using SAP?

A8d. The Jet Propulsion Lab (JPL) is a Federally Funded Research and Development Center (FFRDC) operated under contract by California Institute of Technology (CaITech) CaITech, in this instance, is like any other federal contractor, and is at liberty to operate the business software of its choice. Lockheed Martin and Northrop Grumman, two significant NASA contractors, have chosen SAP.

Q9. What is the value of fully completing the ISS if most of its scientific capabilities are being abandoned? What exactly is NASA expecting to accomplish either technically or scientifically with ISS and how does this justify the continued investment of billions of dollars and 28 risky Shuttle flights? How specifically does ISS contribute to the Exploration Vision given its severely limited capabilities? Would reprogramming some ISS, funds (by reducing the number Shuttle flights and limiting some ISS goals) over to CEV1 development allow for an earlier delivery of CEV and associated independence from Soyuz (along with the reduced exposure to Shuttle failure)?

A9. NASA is in the process of focusing and prioritizing its research and technology development efforts for the International Space Station (ISS) on areas that best contribute to the *Vision for Space Exploration.* ISS provides a unique environment in which the astronaut crew can carry out scientific research, investigating the effects of the space environment both on human physiology as well as on spacecraft systems. NASA has identified 22 areas of research and technology that can be carried out on the International Space Station to reduce the risk associated with future human exploration missions. The ISS can specifically contribute to the *Vision for Space Exploration* in areas such as: testing and validating performance of closed loop life support systems; testing and validating both pharmaceuticals and new exercise systems to maintain astronaut health, and; demonstrating technologies necessary for future space systems such as thermal control, power generation, and management of cryogenic fuels in space.

In response to the question of whether the CEV could be ready sooner, currently CEV development is paced by existing technology maturation timelines and the development and demonstration of a reliable human-rated launch system, all of which

are constrained by available resources. While preliminary indications are that the CEV development could be accelerated, impacts relative to additional costs, performance, program risks, and what actual schedule acceleration can be achieved are yet to be determined. The Exploration Systems Mission Directorate (ESMD) is initiating a six-month study to determine potential CEV schedule acceleration and the concurrent impact on performance, cost, and risk. It is unlikely that CEV deployment could occur as early as 2010, when the Shuttle will be retired.

Questions submitted by Representative Sheila Jackson Lee

Q1a. Members of the Committee were told during the NASA budget hearing that money for safety activities was not put in its own separate budget function but spread throughout the NASA budget.

What is the combined total amount of funding in the NASA budget for safety?

A1a. Safety is one of NASA's core values and is embedded in all we do throughout the Agency. There are certain safety related activities that can be explicitly identified in our budget, and total over $400 million in the FY 2006 request. They include items in Corporate G&A such as the NASA Engineering & Safety Center (NESC), Safety & Mission Assurance (S&MA), and Independent Verification & Validation (IV&V); Center G&A for S&MA; and, Service Pools for S&MA and Independent Technical Authority (ITA). However, this approximate $400 million does not include the amounts expended routinely within programs and projects that contribute to the safety posture of programs and projects outside these specific budget categories, nor does it include safety funding embedded in the work of NASA's contractors.

Q1b. How do the total safety budget projections for the next five years compare with the last two years?

A1b. For the next five years, FY 2006 to FY 2010, the identified safety related budget of over approximately $400 million annually (see (a) above) is increasing at approximately the rate of inflation. There have been some recent changes to elements of the overall safety and related budgets that make it difficult to compare the last two years. These changes include the creation of service pools for ITA and S&MA, which did not exist previously. However, over the past two years, there have been specific increases in the Corporate G&A portion of the identified safety and related funding, for both NESC (an expected ramp-up as that organization has been established) and S&MA. The total funding for these activities increased more than 40 percent from FY 2004 to FY 2005 and then 16 percent from FY 2005 to FY 2006, after which they level off to roughly inflationary increases.

Q2. How many NASA employees will be laid off due to the proposed plan for restructuring? How does NASA project this proposed restructuring to affect recruitment, since rumors of layoffs or closings may dissuade those who may have wanted to join NASA?

A2. NASA is taking a deliberate and thoughtful approach to realigning its workforce to meet the requirements of the *Vision for Space Exploration.* Any reduction in force (RIF) that *may* be needed has always been considered an activity of "last resort." Rather, NASA is currently engaged in Agency-wide initiatives to avoid RIF. These include offering a second round of voluntary separation incentives ("buyouts") and early retirement opportunities at most Centers in April 2005. An earlier round of buyouts was offered in December 2004. Also, the Agency just concluded a series of internal job fairs at Langley Research Center, Glenn Research Center, Ames Research Center and Dryden Flight Research Center designed to realign employees. Hiring managers are currently in the process of selecting from among the job fair applicants. In addition, the Langley Research Center conducted a very successful job fair of private sector employers that they hope will provide job opportunities for their employees. NASA is hopeful that these and similar future RIF avoidance activities will obviate the need for a reduction in force as a result of restructuring.

In addition, there are ongoing efforts to match needed skills with funded work. There will be additional work available for competition as the Exploration program proceeds with its overall program definition, as well as its Crew Exploration Vehicle activity. Work will also be available in various competitive science areas, such as the Discovery and Mars programs.

NASA's ongoing health assessment of its core competencies may result in the application of additional program resources to sustain critical workforce. It is anticipated Centers will pursue reimbursable work for non-NASA customers in their areas of special competence. Centers may also consider alternative management structures for more flexibility to pursue reimbursable tasks. As a result of these ef-

forts, many of the FTEs not yet supported will likely be matched with funded requirements.

NASA will continue to conduct outreach and recruitment activities. The Agency needs to be positioned to attract candidates with the competencies required to support the Exploration Vision. Additionally, we must continue to focus on maintaining a pipeline of recent graduates, particularly in the science and engineering fields, and will use tools such as the NASA Science & Technology Scholarship Program (STSP). This program will award scholarships to individuals to prepare them for careers at NASA. In exchange for tuition scholarships and stipends, STSP award recipients must agree to fulfill a service obligation following graduation. The service obligation equates to serving a two-year appointment with NASA for each academic year under the scholarship, up to a maximum of four required years of service. As always, NASA will also continue to hire students through the Student Education and Employment Program. Our ongoing outreach and recruitment efforts will ensure that the Agency has the appropriate competencies necessary to continue to support NASA's mission.

Questions submitted by Representative Jim Matheson

Q1. How does NASA actually set its budget priorities?

A1. NASA's budget priorities are guided by the President's direction, as outlined in his *Vision for Space Exploration* announced in January 2004. His Vision provides a historic opportunity to focus NASA for the long-term. The Vision was defined in a policy document called "A Renewed Spirit of Discovery: The President's Vision for U.S. Space Exploration." NASA has outlined new objectives in "The New Age of Exploration," which lays out the new approach to space exploration. The FY 2006 Budget Request maintains resolute focus on exploration priorities and critical milestones defined by the President's direction, and informed by our science priorities. Consistent with the Vision, the FY 2006 Budget Request supports critical National needs and revolutionary technologies in other priority areas, including Aeronautics, Earth Science and Education.

Q2. Why do you think that sacrificing NASA's science and aeronautics programs to fund the exploration initiative will be compelling to the Congress, in terms of securing Congressional support? It seems to me that the manned missions to the Moon and Mars are being paid for at the expense of science missions.

A2. While there were reductions in science and aeronautics programs made in the FY 2006 Budget Request relative to earlier plans, those reductions were not made to fund the *Vision for Space Exploration.* In the FY 2006 budget request, reductions were required in all four Mission Directorates as part of a government-wide effort to reduce the deficit, and the need to adequately fund the Space Shuttle return-to-flight activities. The net reductions relative to FY 2006 plans in the FY 2005 budget request were: Science -$274 million; Aeronautics -$105 million; and Exploration Systems -$406 million. Note that the largest reduction was in Exploration Systems.

NASA continues to support important National priorities in Earth Science, Space Science and Aeronautics. Science remains a key driver in the *Vision for Space Exploration.* Funding levels in Science are increasing in the FY06 budget request, with an increase of 23 percent over current levels by 2010. Furthermore, the overall percentage of NASA's budget going to the Science Mission Directorate increases from 33 percent in 2006 to 38 percent by 2010. NASA continues to build the next generation of space telescopes, prepare for robotic missions to the Moon and Mars, and develop new technologies to study our own planet. In Aeronautics Research, the FY 2006 Budget Request fully supports vital research in Aviation Safety and Security and Airspace Systems programs in close cooperation with FAA. In Vehicle Systems, the program's focus has changed from evolutionary to revolutionary, high-risk, "barrier breaking" technologies.

Q3. Why did NASA decide to cancel funding for the Hubble servicing mission, given its popularity with American citizens and its significant contributions to science?

A3. The decision not to pursue a Space Shuttle servicing mission to the Hubble was based on a relative risk analysis and operational complexity. While all space flight is inherently risky, there are both on-orbit and ground processing requirements that would be notably unique to a Hubble servicing mission. For a Hubble servicing mission, the options and available time for dealing with an on-orbit emergency are greatly reduced, posing additional risk to the mission.

NASA has developed a five-point flight rationale (addressing safety requirements) for Space Shuttle RTF, which is grounded in the recommendations of the CAIB and

predicated on primary hazard control, warning devices and special procedures. The first two elements of that flight rationale (*Elimination of Critical Debris* and *Impact Detection During Ascent)* rely upon Space Shuttle hardware, infrastructure, and procedural improvements that broadly apply to all missions, including those to destinations other than the International Space Station (ISS). However, the efforts of the Space Shuttle program to meet the three remaining elements of the RTF flight rationale (*On-Orbit Debris Impact/Damage Detection; On-Orbit Thermal Protection System Repair;* and, *Crew Rescue)* assume access to the resources of the ISS. Developing the additional capabilities necessary to meet these three elements of the flight rationale for a Hubble servicing mission would entail additional risks above and beyond those inherent in a mission to the ISS.

To apply this same flight rationale to a Hubble servicing mission, NASA would have to develop new capabilities that are analogous to those provided by the ISS. The Orbiter Boom Sensor System would have to be extensively modified, or an alternative capability would need to be created. Additionally, a way would need to be found to sustain the crew of a hopelessly crippled Orbiter with limited life-support capabilities long enough for a second Shuttle to be launched on a rescue mission. That rescue mission, in turn, would need to be processed at the same time as the Hubble servicing mission itself, a situation that would be highly complex, would require double the normal workload on ground launch and processing teams, and would put an unprecedented strain on the overall Shuttle system. Finally, a rescue mission would require many unproven techniques, such as emergency free-space crew transfer in space suits while performing Space Shuttle to Space Shuttle station-keeping. Being based at the ISS offers the advantages of multiple hatches, airlocks, and established docking and evacuation procedures, which would afford a shirt-sleeve, nominal transfer of crew from the ISS to the rescue Orbiter.

Based on analysis of the relative risks, operational complexity and implicit schedule pressure, NASA has decided not to proceed with a Shuttle servicing mission of Hubble.

In terms of a robotic servicing mission, the Hubble program office estimated a cost of $1.3 billion over 39 months, with launch in December 2007. Independent reviews have concluded costs could approach $2 billion and development schedule could extend past 5 years. Starting in 2006, Hubble could begin to lose some pointing control. More importantly, batteries are degrading and could become inadequate to protect Hubble in the 2008–2009 timeframe, after which point Hubble would be unsalvageable. Hubble's orbit will not decay to re-entry until the middle of the next decade.

The National Academy of Sciences (NAS) Report released in December 2004 concluded that the likelihood of successful Hubble robotic servicing was highly improbable. The Report strongly recommended termination of robotic servicing in favor of a de-orbit only mission:

> —"[A] robotic mission should be pursued *solely to de-orbit Hubble.*" (emphasis added)

Based on the unambiguous and very strong NAS recommendation, NASA can no longer defend continued effort in support of Hubble robotic servicing. NASA is developing a plan to refocus the program to a de-orbit mission. The PDR occurred, but was focused on inventorying work done to date and on identifying the best approach to the de-orbit only mission. The new NASA Administrator has stated his intention to revisit the earlier decision to not service Hubble with Shuttle in light of what NASA learns after the Shuttle returns to flight.

Q4. In what ways could the preservation and extension of the Hubble Space Telescope help our understanding of dark energy and provide useful insights for future dark energy missions?

A4. Astronomers use measurements of distant supernovae (explosions of aged stars) in other galaxies to determine how fast the universe was expanding at the time of the explosion that began the life of our Universe. The Hubble Space Telescope, along with ground-based telescopes, has been used to trace this "expansion history" of the universe, and has contributed to the recent surprise conclusion that the expansion of the universe is currently *accelerating* (after initially slowing down due to gravity). The physical phenomenon behind this acceleration is not yet understood and is often termed "dark energy." Observations of more supernovae allow the refinement of knowledge of the amount of cosmic deceleration and acceleration over the history of the universe and better determination of numerical parameters that define the "dark energy." Over the next few years, the Advanced Camera for Surveys on Hubble will continue to be used as a search engine to find many more supernovae. Future telescopes may be designed with much larger fields-of-view than available

on Hubble in order to more efficiently detect many supernova explosions in a shorter period.

Questions submitted by Representative Brad Miller

Q1. Please provide a breakdown of the budget for NASA's commercial technology and technology transfer programs for the years FY 2004–2010.

A1. The outyear estimates used to construct the 2006 President's Budget are reflected in the chart below.

	FY 2004	FY 2005+	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
Innovative Partnerships	267.9	188.3	223.2	227.0	222.2	221.4	230.9
Small Business Innovative Research	107.8	110.0	110.2	114.4	118.8	118.9	123.7
Small Technology Transfer Research	13.0	11.7	14.1	12.8	15.1	15.1	15.1
Technology Transfer ***	40.2	18.6	42.1	42.6	43.1	43.4	45.3
Commercial Technology**	36.1	0.0	0.0	0.0	0.0	0.0	0.0
*University Research Engineering & Technology	12.0	12.0	12.0	12.0	0.0	0.0	0.0
*Space Product Development ***	38.0	16.7	16.8	16.9	16.3	15.4	17.9
Program Management and Associated Support	20.8	19.3	27.9	28.4	28.9	28.6	28.8

Notes:
+ The FY 2005 Column represents NASA's first operating plan of December 23, 2004. The Conference Report, which accompanied the Consolidated Appropriations Act for 2005, directed NASA to increase funding to continue commercial programs by $30 million. NASA will identify offsets to fund the $30 million increase in NASA's second FY 2005 operating plan, which will be submitted to Congress in the near future.

* University Research Engineering & Technology Institutes (URETI) is a program that involves seven separate, competitively selected research efforts at various universities. Originally, all URETIs were with the Aeronautics Research Mission Directorate (ARMD). Currently, six are within the Exploration Systems Mission Directorate (ESMD), while one remains within ARMD. Space Product Development was previously managed by the Office of Biological and Physical Research (now the Human Systems Research and Technology Theme) and has been transferred to Innovative Partnerships. The effort is performed at 11 competitively selected Research Partnership Centers and is being managed to provide beneficial technologies for improved quality of life on earth and technology that is needed for exploration.

** Commercial Technology activities were re-evaluated and aligned within other elements of Innovative Partnerships to support the Exploration mission.

*** FY 2004 includes Earmarks and funding for other Congressional appropriations items. While not part of Innovative Partnerships in FY2004, the table above shows URETI and SPD as part of the Program for consistency.

Q2. In what specific ways have you modified NASA's technology transfer programs in response to the National Academy of Public Administration's review of those programs?

A2. The goals of the newly organized Innovative Partnerships Program (IPP) are to:

1) make the *Vision for Space Exploration* affordable through partnerships; and,
2) make it sustainable by creating benefits to the public.

The Innovative Partnerships Program includes the following elements

- Technology Transfer
- Small Business Innovative Research—SBIR
- Small Business Technology Transfer—STTR

- Industry-Led Partnerships
- University-Led Partnerships
  - The Research Partnership Centers (RPCs)
  - University Research Engineering Technology Institutes (URETIs)

Responses to National Academy of Public Administration (NAPA) recommendations are as follows (numbering corresponds to NAPA Report):

1. *Demonstrated Leadership Commitment:* NASA has committed to an improved technology transfer effort by committing new funds in the FY 2006 President's Budget request. The nominee for NASA Administrator has played a leadership role in technology transfer issues throughout his career, including his membership on the NAPA panel, which reviewed the technology transfer programs at NASA.
2. *Relocation:* The Agency elected to place the Technology Transfer program in the IPP Office within the Exploration Systems Mission Directorate (ESMD). The rationale for this move was to make Technology Transfer an integral part of the technology maturation process, engaging the private sector on a broader level in the Exploration Vision. The Technology Transfer efforts along with the SBIR and STTR programs will continue to support the entire Agency's needs.
3. *Mission Directorates Responsible for Spin-In:* Upon receipt of the NAPA report, ESMD transmitted it to the other Mission Directorates, indicating that in the coming year, there would be a series of dialogues between the IPP office and Mission Directorate staffs. The purpose of these dialogues would be to determine the proper approach in meeting the recommendation. Spin-in, or Technology Infusion, is an integral part of the ESMD mission; it also is for the Aeronautics Research Mission Directorate, which has established its own partnerships function for spin-in. We expect similar results with the other Mission Directorates during the coming months.
4. *Center Directors Responsible for Spin-Out:* Upon receipt of the NAPA report, ESMD transmitted it to the NASA Field Center Directors, calling attention in particular to four of the eight recommendations that would require Center attention and asking the Centers to address those recommendations. The IPP office will be working with its Center counter-parts in addressing these recommendations. As part of this, the IPP instituted formal work package agreements with each of the Centers which established performance goals and standards for the IPP program elements.
5. *Restructure External Network:* NASA's Technology Transfer Element is streamlining its External Network competitively awarding this function to a single contractor managed from Headquarters. A draft Statement of Work has been completed. A contract should be awarded by late summer.
6. *Web Sites & Information Systems:* A new contract for the National Technology Transfer System (TechTracS) has just been selected; working in collaboration with the ESMD and Agency Information Technology personnel and Strategic Communications Office, the web sites will be consistent with agency policies and directives as well as satisfying the recommendation made by NAPA. Other improvements to the information system are also underway, also consistent with the NAPA recommendation.
7. *Intellectual Property Processing:* This recommendation is being worked jointly between the Office of General Counsel (OGC) and IPP; the competitive selection of a central external network contractor (item #5) will also address this recommendation. OGC and IPP are in general agreement, and it is recognized that a number of processes will be affected and improved when the new contract is completed.
8. *Rigorous Management:* Program plans are being finalized, task agreements are in place with all Centers, and regular quarterly program reviews are being conducted, the budget and program planning are more fully coordinated, and stronger centralized management controls are being put in place. The role of the IPP leadership team has been strengthened and has become more focused on strategic planning, long-range goals, and annual objectives with targets and measurable results.

Q3. Please provide the funding profile for NASA's Space Grant fellowship program for the years FY 2004–2010. What is the reason for the reduction in funding for the Space Grant program after FY 2006?

A3.

National Space Grant College and Fellowship Program – Funding Profile

(Dollars in Millions)

FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
$ 25.3*	$27.9*	$18.0 **	$16.9 **	$16.9 **	$16.9 **	$16.9 **

* Includes amounts above the President's request as provided through Congressionally-directed appropriations, and reflects this program's proportional share of the Congressionally-directed across-the-board rescission.

** Excludes provision for NASA Corporate General and Administrative (G&A) which is included in amounts for FYs 2004 and 2005. In the FY 2006 budget request and for the out-years NASA Corporate G&A is applied only at the full program level (i.e., Higher Education) and not at the project level (i.e., Space Grant). Historically, the proportional amount of Corporate G&A that could be associated with Space Grant has been between $1.0 million and $1.3 million.

The budget for NASA's Office of Education beyond FY 2006 decreases slightly, consistent with the government-wide effort to reduce the deficit. During the last few years, NASA's Office of Education conducted formal assessments of its education programs, eliminating or restructuring those programs determined to be less efficient and effective. To accommodate the new lower planning level for FY 2007 and beyond, and having already eliminated many less effective programs, it was necessary to reduce the planning amounts for remaining Education programs and projects, including Space Grant. During the FY 2007 budget cycle, we expect to reassess all program budgets, including the Space Grant budget, to better identify resource needs. The FY 2007 budget request will reflect the results of this reassessment.

Questions submitted by Representative Michael T. McCaul

Q1. I am happy to see that NASA is making headway in meeting the recommendations of the Columbia *Accident Investigation Board, and aims to return the Shuttle to flight as early as May or June of this year. Do you see any specific reason that NASA would not reach its goal of May–June for a return flight to space?*

A1. All major Space Shuttle flight hardware is at the Kennedy Space Center in Florida and is being processed through a normal pre-launch flow. Meanwhile, the independent Return-to-Flight Task Group (RTFTG) continues to assess NASA's efforts to meet the fifteen Return-to-Flight recommendations made by the *Columbia* Accident Investigation Board (CAIB). The RTFTG met in plenary session on March 29–31, 2005 to consider the remaining open CAIB Return-to-Flight activities. In the words of RTFTG co-chair Richard Covey, "Right now, we don't see anything that stands in front of the Agency that can't be accomplished in order to make the May–June [2005] launch window."

Nevertheless, this and all future flights will be driven by safety milestones. If there is any indication that additional work needs to be done to meet those milestones, then the Space Shuttle program will take whatever measures are appropriate to ensure that those milestones are met—up to and including delaying launches, if necessary.

Q2. The phase-out date of the Space Shuttle, corresponding with the completion of the International Space Station, is slated for sometime in 2010, and the Crew Exploration Vehicle (CEV) is not expected to carry humans into space until 2014. Will there be no manned flights by NASA between 2010 and 2014, and is there a possibility that the CEV could be ready sooner?

A2. It is important to note that the President's *Vision for Space Exploration* called for the Crew Exploration Vehicle to be ready no later than 2014. Administrator Griffin has stated his determination to endeavor to have the Crew Exploration Vehicle ready earlier than 2014, thus reducing any potential "gap."

The current schedule for CEV calls for risk reduction demonstrations in 2008, followed by uncrewed full up vehicle tests commencing in 2011. It is anticipated that

Exploration Systems Mission Directorate's (ESMD) current acquisition plan will result in the first crewed flight of the CEV in 2014. In the interim between Shuttle retirement in 2010 and the first crewed flight of the CEV, NASA Astronauts will continue to conduct human research activity on the International Space Station with transportation provided by the Soyuz, and potentially other vehicles.

In response to the question of whether the CEV could be ready sooner, currently CEV development is paced by the maturity of technology and the demonstration of a reliable human rated launch system, both of which are constrained by available resources. ESMD is initiating a six-month study to determine potential CEV schedule acceleration and the concurrent impact in performance, cost and risk. While preliminary indications are that the CEV development could be accelerated, impacts relative to additional costs, performance, program risks, and what actual schedule acceleration can be achieved will have to be determined—particularly with respect to the human rated launch system requirement. It is unlikely that CEV deployment could occur as early as 2010, when the Shuttle will be retired.

Appendix 2:

Additional Material for the Record

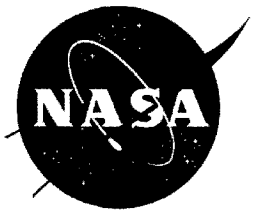
National Aeronautics and Space Administration
President's FY 2006 Budget Request

(Budget authority, $ in millions)	FULL COST						Chapter Number
By Appropriation Account	Initial Operating Plan 12/23/04						
By Mission Directorate By Theme	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	
Science, Aeronautics, and Exploration	**9,334.7**	**9,661.0**	**10,549.8**	**11,214.6**	**12,209.6**	**12,796.1**	SAE SUM-1
Science*	**5,527.2**	**5,476.3**	**5,960.3**	**6,503.4**	**6,853.0**	**6,797.6**	SAE 1
Solar System Exploration	1,858.1	1,900.5	2,347.7	2,831.8	2,998.9	3,066.1	SAE 2
The Universe	1,513.2	1,512.2	1,531.5	1,539.4	1,495.0	1,406.7	SAE 3
Earth-Sun System	2,155.8	2,063.6	2,081.2	2,132.2	2,359.0	2,324.8	SAE 4
Exploration Systems**	**2,684.5**	**3,165.4**	**3,707.0**	**3,825.9**	**4,473.7**	**5,125.5**	SAE 5
Constellation Systems	526.0	1,120.1	1,579.5	1,523.7	1,990.9	2,452.2	SAE 6
Exploration Systems Research and Technology	722.8	919.2	907.3	989.2	1,050.3	1,078.5	SAE 7
Prometheus Nuclear Systems and Technology	431.7	319.6	423.5	500.6	614.0	779.0	SAE 8
Human Systems Research and Technology	1,003.9	806.5	796.7	812.4	818.5	815.8	SAE 9
Aeronautics Research	**906.2**	**852.3**	**727.6**	**730.7**	**727.5**	**717.6**	SAE 10
Aeronautics Technology	906.2	852.3	727.6	730.7	727.5	717.6	SAE 11
Education Programs	**216.7**	**166.9**	**154.9**	**154.7**	**155.4**	**155.4**	SAE 12
Education Programs	216.7	166.9	154.9	154.7	155.4	155.4	SAE 13
Exploration Capabilities	**6,704.4**	**6,763.0**	**6,378.6**	**6,056.7**	**5,367.1**	**5,193.8**	EC-SUM 1
Space Operations	**6,704.4**	**6,763.0**	**6,378.6**	**6,056.7**	**5,367.1**	**5,193.8**	EC 1
International Space Station	1,676.3	1,856.7	1,835.3	1,790.9	2,152.3	2,375.5	EC 2
Space Shuttle	4,543.0	4,530.6	4,172.4	3,865.7	2,815.1	2,419.2	EC 3
Space and Flight Support	485.1	375.6	370.9	400.0	399.7	399.1	EC 4
Inspector General	**31.3**	**32.4**	**33.5**	**34.6**	**35.2**	**37.3**	IG 1
TOTAL	**16,070.4**	**16,456.3**	**16,962.0**	**17,305.9**	**17,611.9**	**18,027.1**	
Year to year increase		2.4%	3.1%	2.0%	1.8%	2.4%	
Emergency Hurricane Supplemental	126.0						

*Science Mission Directorate reflects the combination of the former Space Science and Earth Science Enterprises.
**Beginning in FY 2006, Exploration Systems moves from Exploration Capabilities to Science, Aeronautics and Exploration. Exploration Systems Mission Directorate reflects the combination of the former Biological & Physical Research and Exploration Systems Enterprises.

Totals may not add due to rounding.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



FY 2006 Budget Request Summary

The Exploration Vision is Well Under Way

On January 14, 2004, President George W. Bush announced *A Renewed Spirit of Discovery: The President's Vision for U.S. Space Exploration*, a new directive for the Nation's future in space exploration. The fundamental goal of this directive is "...to advance U.S. scientific, security, and economic interests through a robust space exploration program." In issuing it, the President committed the Nation to a journey of exploration, returning humans to the Moon by the year 2020, then venturing further into the solar system, ultimately sending humans to Mars and other destinations. He challenged NASA to establish new and innovative programs to enhance understanding of the planets, ask new questions, and answer questions as old as humankind.

The *Vision for Space Exploration*, published in February 2004, embodies the strategy and guiding principles NASA will follow in pursuing the President's directive. The *Vision* lays out important, fundamental goals and embodies a strategy of specific milestones that will move NASA and the Nation forward in the years to come.

The President demonstrated his commitment to the *Vision for Space Exploration*, and Congress supported this commitment, with full funding for NASA at the budget level requested for FY 2005. The President reaffirmed this commitment by providing NASA with a 2.4 percent increase for FY 2006 to meet established critical priorities and milestones.

The FY 2006 budget identifies what is needed to continue transforming America's civil space program. It preserves the priorities, milestones, and schedules introduced with the *Vision* in the FY 2005 budget, and it supports NASA's continuing organizational and cultural transformation through new management organizations and a revised budget structure consistent with the recommendations of the *President's Commission on Implementation of the United States Space Exploration Policy* (Aldridge Commission). The budget for FY 2006 continues to support the *Vision for Space Exploration* and is reflected in *The New Age of Exploration: NASA's Direction for 2005 and Beyond*, a new document that outlines NASA's strategic planning efforts and the Agency's commitment to implementing and achieving the *Vision*. *The New Age of Exploration* also establishes the new NASA Strategic Objectives that are reflected in the FY 2006 Budget.

The 2006 budget maintains a focus on key exploration priorities and critical milestones informed by NASA's science priorities:

- First Step—Space Shuttle return to flight and completion of International Space Station assembly.
- Flagship Program—Project Constellation (maintain 2008 CEV flight demonstration).
- Technology Base—Critical exploration technologies.
- Transforming Technologies—Project Prometheus (flight demonstration in a decade).
- Robotic Precursors—Lunar missions beginning in 2008 and Mars missions added in 2011.
- Shuttle Transition—ISS cargo and crew services via near-term commercial service.
- Scientific Breakthroughs—Exploration of the solar system and the universe (e.g., James Webb Space Telescope to be launched in 2011) and the search for Earth-like planets.

The budget also supports critical national needs and revolutionary technologies in aeronautics, climate change, and education.

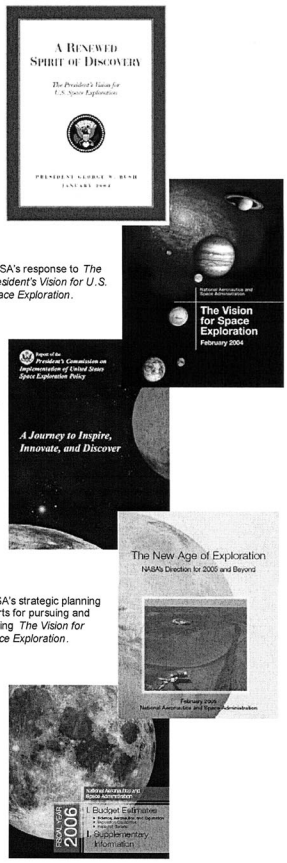
Transforming NASA

Guided by NASA's core values of Safety, the NASA Family, Excellence, and Integrity, the Agency is changing to meet the needs the *Vision*. First, NASA is embedding a safety culture throughout the organization. The Agency has reduced workforce accident rates to industrial world-class standards and implemented an Independent Technical Authority to guide NASA's continued improvement.

NASA is embracing competition. The Agency is using competitive processes to elicit the best from industry, academia, and NASA's Centers. NASA is seeking innovation from all sources by casting a broad net worldwide in search of beneficial partnerships and innovative solutions to technical and management challenges.

NASA is enhancing the Agency's long range planning processes and improving decision-making. The Agency's transformed structure includes a Strategic Planning Council and a supporting Office of Advanced Planning and Integration to enable better long-range planning, an Operations Council to integrate NASA's tactical and operational decisions, and a revised advisory council to integrate Agency activities. And, NASA's 2006 Strategic Plan will be based on a set of strategic and capability roadmaps currently being developed by national teams of external and NASA experts to ensure that NASA's activities are aligned with the *Vision for Space Exploration.*

NASA has streamlined the Agency's corporate structure by cutting the number of Headquarters organizations in half. As of August 2004, NASA has four Mission Directorates—Exploration Systems, Space Operations, Science, and Aeronautics Research—and eight Mission Support Offices, including the Office of Education and the Office of Safety and Mission Assurance. And, to reinvigorate NASA's Centers, Agency leaders are identifying core competencies and reviewing possible alternate management structures for NASA's Centers.



The President's Policy Directive

NASA's response to *The President's Vision for U.S. Space Exploration*.

The Aldridge Commission Report on how NASA should proceed with implementing *The Vision for Space Exploration*.

NASA's strategic planning efforts for pursuing and fulfilling *The Vision for Space Exploration*.

NASA's FY 2006 Budget Request details how *The Vision for Space Exploration* and its related activities will be funded and sustained.

Finally, NASA is building a sound management foundation. NASA scored well on the President's Management Agenda initiatives in 2004, especially in developing and implementing new tools to recruit the next generation of engineers, scientists, and astronauts.

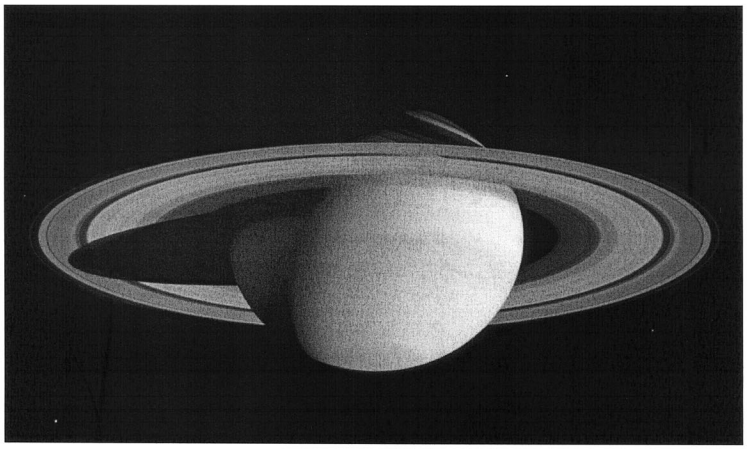
Making Great Progress

NASA's transformation and journey to achieving the *Vision for Space Exploration* is off to a strong start. NASA is making final preparations to return the Space Shuttle to flight, and this year NASA began its fifth year of continuous astronaut presence in space aboard the International Space Station.

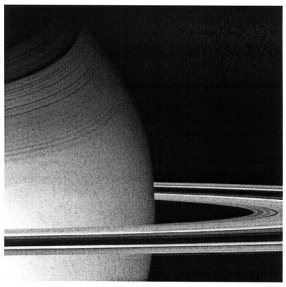
NASA is moving further into the solar system. The Mars rovers, *Spirit* and *Opportunity*, are exceeding all goals with their unprecedented discoveries and longevity. They found definitive evidence of water on the Red Planet and continue to gather data more than a year after their successful landing. The Cassini–Huygens spacecraft entered Saturn's orbit and sent back breath-taking images of that planet's rings and moons. The Genesis mission successfully returned primordial samples from space. MESSENGER launched to visit and map Mercury while NASA's eyes in the sky, including Hubble, Chandra, and Spitzer, continued to amaze the world with images from the deepest reaches of space. And, with NASA's international partners, the Agency added to the constellation of Earth observing satellites that monitor this fragile planet.

NASA also is laying the groundwork for the future. The Agency competitively awarded 118 contracts for exploration technologies based on an overwhelming response to the call for proposals. NASA began the Crew Exploration Vehicle competition process, and flight demonstrations are planned for 2008. The Agency is putting the building blocks in place to return astronauts to the Moon, and early preparations have begun – including system design and technology tests for nuclear power in place – to ensure that explorers head for Mars and other destinations on schedule.

NASA and the *Vision for Space Exploration* are generating worldwide excitement. Over 17 billion hits on NASA's Web site is evidence of public interest in America's space exploration program.



Science Mission Directorate

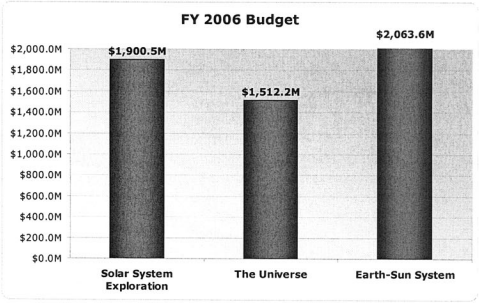


The newly organized Science Mission Directorate (SMD) engages the Nation's science community, sponsors scientific research, and develops and deploys satellites and probes in collaboration with NASA's partners around the world to answer fundamental questions requiring the view from and into space. SMD seeks to understand the origins, evolution, and destiny of the universe and to understand the nature of the strange phenomena that shape it. SMD also seeks to understand: the nature of life in the universe and what kinds of life may exist beyond Earth; the solar system, both scientifically and in preparation for human exploration; and the Sun and Earth, changes in the Earth-Sun system, and the consequences of the Earth-Sun relationship for life on Earth.

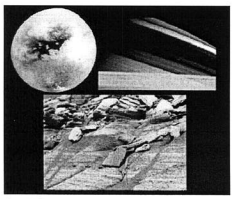
The Science Mission Directorate also sponsors research that both enables, and is enabled by, NASA's exploration activities. The SMD portfolio is contributing to NASA's achievement of the *Vision for Space Exploration* by striving to:

- Understand the history of Mars and the formation of the solar system. By understanding the formation of diverse terrestrial planets (with atmospheres) in the solar system, researchers learn more about Earth's future and the most promising opportunities for habitation beyond our planet. For example, differences in the impacts of collisional processes on Earth, the Moon, and Mars can provide clues about differences in origin and evolution of each of these bodies.
- Search for Earth-like planets and habitable environments around other stars. SMD pursues multiple research strategies with the goal of developing effective astronomically-detectable signatures of biological processes. The study of the Earth-Sun system may help researchers identify atmospheric biosignatures that distinguish Earth-like (and potentially habitable) planets around nearby stars. An understanding of the origin of life and the time evolution of the atmosphere on Earth may reveal likely signatures of life on extrasolar planets.
- Explore the solar system for scientific purposes while supporting safe robotic and human exploration of space. For example, large-scale coronal mass ejections from the Sun can cause potentially lethal consequences for improperly shielded human flight systems, as well as some types of robotic systems. SMD's pursuit of interdisciplinary scientific research focus areas will help predict potentially harmful conditions in space and protect NASA's robotic and human explorers.

In recent years, NASA science missions and research have returned spectacular and important results. Space observations have played a central role in these fascinating discoveries. From activities directly supporting the *Vision for Space Exploration* and investigations of the structures and processes at work in the universe to studies of Earth, NASA's Science Mission Directorate will continue to build upon its past successes.



Solar System Exploration Theme



The Solar System Exploration (SSE) Theme seeks to understand how the solar system formed and evolved, and whether there might be life in the solar system beyond Earth. This Theme pursues three simple yet profound questions: Where do we come from? What is our destiny? Are we alone? These overarching questions lead to more focused questions about our solar system: How do planets and their satellites form and how have they evolved over the lifetime of the solar system? How are the planets alike and how do they differ and why? What physical and chemical conditions and history must a planet have in order to be suitable for life? How were the ingredients for life, water and simple organic substances, brought to the inner terrestrial planets?

Planets and satellites receiving special attention in the SSE Theme include Mars and the Moon. The Mars program will continue to determine the planet's physical, dynamic, and geological characteristics. It will also investigate both the variability of the Martian climate in the context of understanding habitability and whether Mars ever harbored any kind of life. The Lunar program's main focus will be demonstrating capabilities to conduct sustained research on Mars as well as deeper and more advanced explorations of the solar system. Discovery and New Frontiers are competed and peer reviewed programs that give the scientific community the opportunity to assemble a team and design focused science investigations that complement other science explorations. Technology investments in propulsion and radioisotope power systems will reduce mission costs and increase capabilities for exploration and science return. The Research program provides new scientific understanding and instrumentation that enables the next generation of flight missions. Deep Space Mission Systems provides capabilities and infrastructures for tracking, navigation, and data return to Earth to support interplanetary spacecraft missions.

OVERALL BUDGET

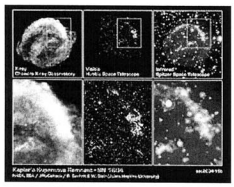
The FY 2006 request is $1,900.5 million, including:

- $858 million for Mars and lunar robotic exploration (a 17 percent increase above FY 2005), following up NASA's success with the *Spirit* and *Opportunity* rovers with the Mars Reconnaissance Orbiter, Mars Science Laboratory, Lunar Reconnaissance Orbiter, and the competition for Phoenix, a new mission to look for complex organic chemicals.

MAJOR ACTIVITIES PLANNED FOR FY 2006:

- Launch the first New Frontiers mission, to Pluto and the Kuiper Belt in January 2006.
- Insert the Mars Reconnaissance Orbiter into orbit around Mars and begin science investigations.
- Achieve a major MESSENGER Discovery mission milestone with the flyby of Venus (on the way to Mercury).
- Return the Stardust Discovery mission science samples to Earth in January 2006.
- Launch the Dawn Discovery mission by July 2006.

The Universe Theme



How did the universe begin? How will it end? Does time have a beginning and an end? The universe is a dynamic, evolving place governed by cycles of matter and energy. Through the Universe Theme, NASA seeks to understand these cycles and how they created the unique conditions that support life. Astronomers search for answers to these questions by looking far away, towards the beginning of time, to see galaxies forming, and close to home, in search of planetary systems around nearby stars.

The Universe suite of operating missions includes three Great Observatories which have helped astronomers unravel the mysteries of the cosmos: the Hubble Space Telescope, which has literally rewritten astronomy textbooks since its launch in 1990; the Chandra X-Ray Observatory in 1999, and the Spitzer Space Telescope in 2003.

In the years to come, new technologies and more powerful instruments will allow the Universe Theme's Beyond Einstein missions to look deeper into the cosmos, going to the edge of black holes and nearly to the beginning of time. In the search for origins, scientists will peer one-by-one at hundreds of Earth's nearest neighbor stars and inventory their planets, searching for solar systems resembling this one with a balmy, wet planet like Earth. Researchers do not yet know whether other similar worlds are common or exceedingly rare, but the journey to discovery has already begun.

OVERALL BUDGET

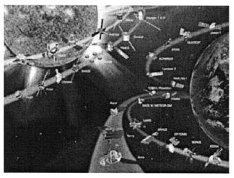
The FY 2006 request is $1,512.2 million, including:

- $372 million to the James Webb Space Telescope (a 19 percent increase above FY 2005) for a wide array of detailed flight design and long-lead procurement and flight hardware fabrication efforts.
- $56 million for Beyond Einstein (a 33 percent increase above FY 2005) to test and validate theories about the nature of the universe.

MAJOR ACTIVITIES PLANNED FOR FY 2006:

- Gravity Probe B science results will become available.
- James Webb Space Telescope confirmation to enter development phase.
- The Keck Interferometer nulling mode will become available for key project observing.
- The Large Binocular Telescope Interferometer will be commissioned.

Earth-Sun System Theme



Life on Earth prospers in a climate powered by energy from the Sun that is moderated by water and carbon cycles and protected from the harshness of space by Earth's enveloping magnetic field and an atmosphere. The Earth-Sun System (ESS) Theme is comprised of research programs to understand how the Earth system is changing, to probe the connections between the Sun, Earth, and the rest of the solar system, and to discern the consequences for life on Earth. Working with the Agency's domestic and international partners, NASA provides accurate, objective scientific data and analyses to advance understanding of Earth-Sun system processes and phenomena. This advanced understanding enables improved prediction and response capabilities for climate, weather, natural hazards, and even human-induced disasters. NASA is expanding and using its constellation of over 28 Earth-Sun observing satellites routinely making measurements with over 100 remote sensing instruments.

NASA has defined two strategic objectives within the Earth-Sun System Theme: (1) conduct a program of research and technology development to advance Earth observation from space, improve scientific understanding, and demonstrate new technologies with the potential to improve future operational systems; and (2) explore the Sun's connection to the solar system to understand the Sun and its effects on Earth, the solar system, and the space environmental conditions that will be experienced by human explorers, and demonstrate technologies with the potential to improve future operational systems.

NASA FY 2006 Budget Request Summary

OVERALL BUDGET

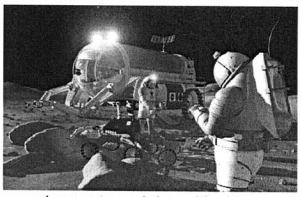
The FY 2006 request is $2,063.6 million, including:

- $243 million for Living with a Star (a 16 percent increase above FY 2005) to investigate the variability of the Sun and its impact on Earth.
- $136 million for Earth System Science Pathfinder (a 26 percent increase above FY 2005), including CloudSat, Cloud-aerosol LIDAR and Infrared Pathfinder Satellite Observation (CALIPSO), Orbiting Carbon Observatory, Hydros, and Aquarius.
- $845 million for Earth-Sun research (a three percent increase above FY 2005) to improve NASA's capability to predict weather, climate, natural hazards, and space weather.

MAJOR ACTIVITIES PLANNED FOR FY 2006:

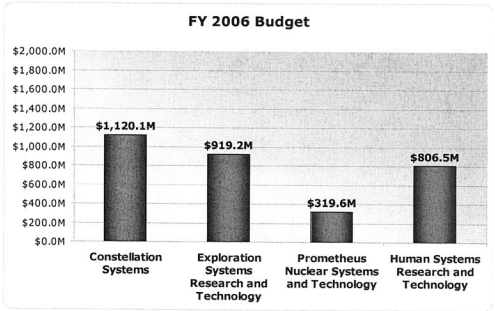
- Ready Solar Dynamics Observatory and NPP for launch.
- Launch the Solar-Terrestrial Relations Observatory (STEREO).
- Retrieve/distribute scientific data from Cloudsat and CALIPSO.
- Continue development of the Orbiting Carbon Observatory and Aquarius.

Exploration Systems Mission Directorate

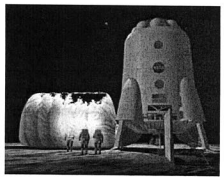


The role of the Exploration Systems Mission Directorate (ESMD) is to develop a constellation of new capabilities, supporting technologies, and foundational research that enables sustained and affordable human and robotic exploration. The research and technology development activities of the former Exploration Systems Enterprise and former Biological and Physical Research Enterprise have been merged into ESMD. In this way, ESMD can integrate fully the broad engineering systems infrastructure requirements and the critical human system requirements necessary for human exploration of the solar system to ensure safety, sustainability, and exploration crew effectiveness.

The Exploration Systems Mission Directorate consists of four Themes that will function cooperatively to enable exploration and scientific discovery: Exploration Systems Research and Technology; Human System Research and Technology; Constellation Systems; and Prometheus Nuclear Systems and Technology.



Constellation Systems Theme



Through the Constellation Systems Theme, NASA will develop, demonstrate, and deploy the collection of systems that will enable sustained human and robotic exploration of the Moon, Mars, and beyond. These include the Crew Exploration Vehicle (CEV) for the transport and support of human crews traveling to destinations beyond low Earth orbit, as well as launch vehicles for transport of the CEV and cargo to low Earth orbit, and any ground or in-space support infrastructure for communications and operations.

These systems, collectively known as the "System of Systems," will be developed in a "spiral" approach in which early prototypes are used to demonstrate capabilities, validate technologies, and mitigate risk, all along an evolutionary path toward a mature design. The first spiral development planned for Constellation Systems will provide the capability to deliver humans to orbit in a CEV by 2014. The second spiral will deliver humans to the lunar surface by 2020, followed by the third spiral that will enable extended visits on the lunar surface. As spiral development evolves, System of Systems elements will grow to include in-space support systems, destination surface systems, and additional human support systems.

Overall Budget

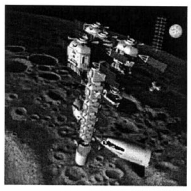
The FY 2006 request is $1,120.1 million, including:

- $753 million for the Crew Exploration Vehicle, America's future workhorse for safe and affordable human exploration, with resources to pursue a timely flight demonstration in 2008.

MAJOR ACTIVITIES PLANNED FOR FY 2006:

- System Requirements Review of the Earth Orbit Capability (Spiral 1) program.
- Begin the Concept Development and Preliminary Design phase of the Earth Orbit Capability (Spiral 1) program.

Exploration Systems Research and Technology Theme



The Exploration Systems Research and Technology (ESR&T) Theme represents NASA's commitment to investing in the technologies and capabilities that will make the national *Vision for Space Exploration* possible. Solar system exploration will benefit all of NASA and will be the primary focus of this Theme's activities, demanding a robust, ongoing commitment to innovation. Through such a focused research and development effort, the Theme will develop technologies that can be integrated into different spirals and different missions at appropriate times. The ESR&T Theme is working closely with other government agencies, industry, academia, and other partners to leverage common requirements and identify innovative ideas.

OVERALL BUDGET

The FY 2006 request is $919.2 million (a 27 percent increase above FY 2005), including:

- Funding for the Advanced Space Technology and Technology Maturation programs to continue competitively awarded innovative technology development contracts to NASA Centers, industry, and academia.
- An increase of $34 million for a newly restructured Technology Transfer Partnerships project to improve NASA's ability to both spin-out and spin-in new technologies.
- $34 million for the Centennial Challenges program.

MAJOR ACTIVITIES PLANNED FOR FY 2006:

- Assess and address critical in-house capabilities and technology gaps.
- Issue a Broad Agency Announcement to fill critical technology gaps for development of the Crew Exploration Vehicle (Spiral 1) and the first human lunar landing missions (Spiral 2).
- Complete Phase I of Advanced Space Technology and Technology Maturation projects and initial validation of new concepts and technologies.

Prometheus Nuclear Systems and Technology Theme

Prometheus Nuclear Systems and Technology represents NASA's effort to develop an advanced technology capability for more complex operations and exploration of the solar system. Historically, space exploration has been limited by the power available from solar and other non-nuclear sources. Radioisotope power systems, a passive form of nuclear power, have enabled a wide range of outer planetary exploration missions over the past 40 years, as evidenced by the Galileo and Cassini spacecraft.

The development of more sophisticated, more capable (i.e., heavier) spacecraft, and the potential need for more robust power systems on the surface of the Moon or Mars, may require the development of the more powerful and efficient capability provided by nuclear fission. In cooperation with the Department of Energy, NASA's current research and development effort is focused on the first demonstration of a space-based nuclear reactor.

NASA FY 2006 Budget Request Summary

OVERALL BUDGET

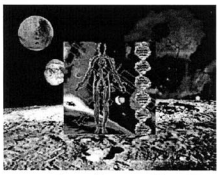
The FY 2006 request is $319.6 million, including:

- Funding to support the initial development of a first-ever demonstration of space-based nuclear power.
- Funding to support research and development for technologies such as advanced materials, advanced power conversion, and advanced propulsion systems that will be applicable to future missions relevant to both the science and exploration goals of the *Vision*.

MAJOR ACTIVITIES PLANNED FOR FY 2006:

- Conduct the "NASA Dialogue on Nuclear Energy for Space Exploration" to understand public concerns and engage diverse stakeholders in discussions on the need and uses of these technologies.
- Conduct advanced research and development and conceptual studies for follow-on and second-generation missions and applications.
- Following completion of the Prometheus Analysis of Alternatives, initiate preliminary design of a nuclear demonstration mission.
- Conduct technology development of structures, systems, and components for an initial nuclear technology demonstration.

Human Systems Research and Technology Theme



The Human Systems Research and Technology (HSR&T) Theme is new to ESMD and is comprised of several initiatives formerly in the Biological and Physical Research Enterprise (BPRE). The programs of BPRE have been transformed from a discipline focus on biological and physical research to a requirements-driven, product-delivery focus. The Theme now focuses on ensuring the health, safety, and security of humans throughout the course of solar system exploration. Programs within this Theme advance knowledge and technology critical for supporting long-term human survival and performance during operations beyond low Earth orbit, with a focus on improving medical care and human health maintenance.

OVERALL BUDGET

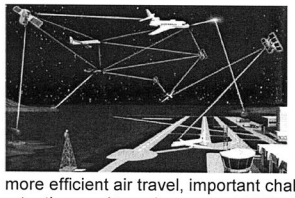
The FY 2006 request is $806.5 million, including:

- Funding for three new programs that better align former research activities with present needs and improve NASA's ability to achieve the goals identified in the *Vision*. By transforming the BPRE organization and adopting a requirements-based philosophy in the redirection of its programs, NASA will be able to reprioritize International Space Station research and realize efficiencies in its investments by focusing them on technologies applicable to human exploration of the solar system. Such efficiencies allow NASA to adjust the investment profile for HSR&T and still return significant benefits to the space program.
- The Life Support and Habitation program conducts research and develops technology for life support and other critical systems for spacecraft operations.
- The Human Health and Performance program delivers research on questions about human biology and physiology relevant to the human exploration of the solar system, and delivers technology to help maintain or improve human health in the space environment.
- The Human Systems Integration program focuses on optimizing human-machine interaction in the operation of spacecraft systems.

MAJOR ACTIVITIES PLANNED FOR FY 2006:

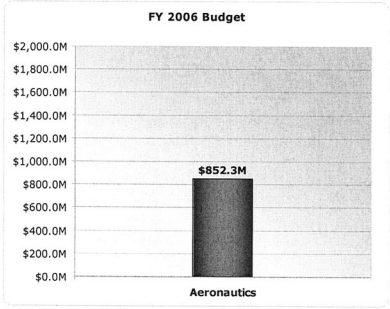
- Complete the technology trade studies for both the in-space and surface extra-vehicular activity (EVA) suits.
- Revise and update standards for human cognition, human performance, assessment, and human interfaces.
- Complete study and deliver report on lunar radiation protection requirements.
- Early completion of the renal stone countermeasure development project.
- Begin testing of bone and cardiovascular countermeasures in space.

Aeronautics Research Mission Directorate

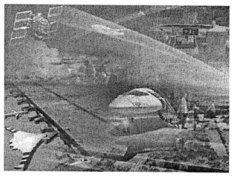


Over the last century, aviation has evolved into an integral part of our economy, a cornerstone of national defense, and an essential component of everyday life. Aviation generates more than $1 trillion in economic activity in the United States every year. Americans rely on aviation not just for transportation, but for recreation as well. The ability of aviation to offer safe, affordable, fast, predictable movement of goods and people has fueled the industry's growth. But, just as the Nation has become more dependent on faster and more efficient air travel, important challenges have emerged: the need to reduce the fatal accident rate; the need to enhance post-9/11 air travel safety and security; the need to reduce air and noise pollution that restrict the number and type of aircraft operating in certain areas; and the need to improve the efficiency/capacity of the air traffic and airport systems.

The Aeronautics Research Mission Directorate (ARMD) supports NASA's mission to understand and protect Earth by playing a key role in the technology developments needed to resolve the challenges faced by the aeronautics community and create a safer, more secure, environmentally friendly, and efficient national aviation system. Research areas include: advanced propulsion technologies using hydrogen fuel; airframe and propulsion technologies for noise reduction; lightweight, high-strength structures; modern decision support tools; revolutionary display and control systems; adverse weather countermeasures; adaptive controls; and advanced vehicle designs. In collaboration with the Federal Aviation Administration (FAA), NASA conducts research in air traffic management technologies for new automation tools and concepts operations. In collaboration with the Department of Homeland Security, NASA conducts similar research to improve the security of the National Airspace System.



Aeronautics Technology Theme



The Aeronautics Technology Theme (AT) serves the Nation by developing technologies to improve aircraft and air transportation system safety, security, and performance; reduce aircraft noise and emissions; and increase the capacity and efficiency of the National Airspace System. AT also conducts research that will enable the use of uncrewed aerial vehicles (UAVs) for revolutionary Earth and space science missions.

AT partners with other government agencies, academia, and industry to enhance research efforts and to ensure effective development and transfer of new technologies. As part of a national effort, NASA and the FAA Joint Planning and Development Office have developed an integrated plan for the Next Generation Air Transportation System that will transform America's air transportation network by 2025.

AT consists of three integrated programs: the Aviation Safety and Security program mitigates actions that would cause damage or loss of life; the Airspace Systems program enables revolutionary improvements to the National Airspace System; and the Vehicle Systems program, which has been restructured to emphasize breakthrough technologies and demonstrations, works to reduce aircraft noise, support development of zero-emissions aircraft, and develop UAVs for Earth and space science missions.

MAJOR ACTIVITIES PLANNED FOR FY 2006:

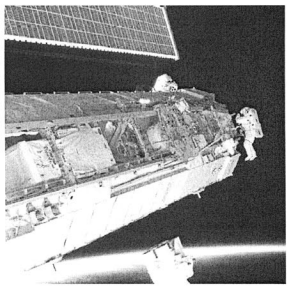
- Develop a modeling and simulation capability for National Airspace Systems.
- Develop strategic management tools for National Airspace System.
- Develop wake vortex operation procedures/standards to safely increase the terminal area capacity, and allow reduced separation standards for wake vortex avoidance considerations.
- Demonstrate prototype Distributed National Archives for Flight Operations Quality Assurance and Aviation Safety Action Program (ASAP) data with participation of multiple airlines

OVERALL BUDGET

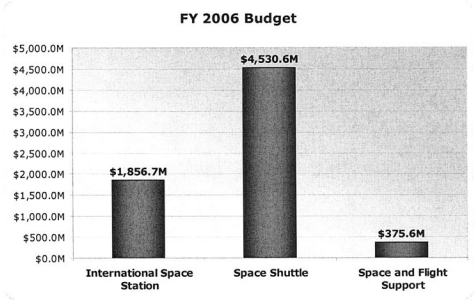
The FY 2006 request is $852.3 million, including:

- $193 million for Aviation Safety and Security (a four percent increase above FY 2005) to decrease aviation accident and fatality rates.
- $200 million for Airspace Systems (a 32 percent increase above FY 2005) to provide technologies that can dramatically increase the capacity and mobility of the Nation's air transportation system.

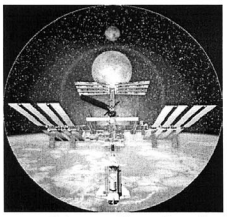
Space Operations Mission Directorate



The Space Operations Mission Directorate (SOMD) programs ensure that NASA's human and robotic explorers have reliable, safe, and affordable access to space while creating new exploration and research opportunities through the extension of human presence in space. The SOMD enables NASA to achieve its goals by providing: transportation systems like the Space Shuttle; operational research facilities in space like the International Space Station (ISS); and space communications systems and its supporting infrastructure. The SOMD also provides the unique human system necessary to open the space frontier as broadly as possible.



International Space Station Theme



The International Space Station Theme supports the construction and operation of a research facility in low Earth orbit as one of the first steps toward achieving the *Vision for Space Exploration*. The ISS provides a unique, continuously operating research facility in which researchers can develop and test medical countermeasures and engineering solutions for long-term human space travel while providing ongoing practical experience in living and working in space. The ISS Theme also supports a variety of pure and applied research for the United States and its international partners.

ISS assembly will be completed by the end of the decade. NASA is examining configurations for the ISS that meets the needs of both the Vision for Space Exploration and Agency's international partners using as few Space Shuttle flights as possible. A key element of the ISS program is the crew and cargo services project, which will purchase services for cargo and crew transport using existing and emerging capabilities.

Overall Budget

The FY 2006 request is $1,856.7 million, including:

- $1,697 million (a seven percent increase above FY 2005) for continuous on-orbit operations and assembly after the Shuttle return to flight;
- $ 160 million for the acquisition of cargo and crew services for the acquisition of cargo and crew services to support the ISS.

NASA FY 2006 Budget Request Summary

MAJOR ACTIVITIES PLANNED FOR FY 2006:

- Reestablish on-orbit crew of three as early as Shuttle flight ULF1.1.
- Select commercial transportation service provider(s).
- Resume assembly of ISS.
- Maintain on-orbit operations.

Space Shuttle

The Space Shuttle is currently the only launch capability owned by the United States that enables human access to space, and it is currently the only vehicle that can support assembly of the ISS. NASA will phase-out the Space Shuttle in 2010 when its role in ISS assembly is complete.

OVERALL BUDGET:

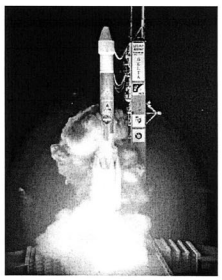
The FY 2006 request is $4,530.6 million. This budget will enable:

- Five Space Shuttle flights to the International Space Station to continue assemble.
- Planning for the phase-out of the Space Shuttle program in 2010, after nearly 30 years of service.

MAJOR ACTIVITIES PLANNED FOR FY 2006:

- Ensure the proper technical integration of all Space Shuttle elements.
- Safely fly planned Space Shuttle manifest.
- Initiate early actions for an orderly phase-out of the Space Shuttle program.

Space and Flight Support



This Space and Flight Support Theme encompasses Space Communications, Launch Services, Rocket Propulsion Testing, and Crew Health and Safety. Space Communications consists of: (1) the Tracking and Data Relay Satellite System (TDRSS), which supports activities such as the Space Shuttle, ISS, Expendable Launch Vehicles, and research aircraft; and (2) the NASA Integrated Services Network, which provides telecommunications services at facilities, like flight support networks, mission control centers, and science facilities, and administrative communications networks for NASA Centers. The Launch Services program focuses on meeting the Agency's launch and payload processing requirements by assuring safe and cost-effective access to space via the Space Shuttle and expendable launch vehicles. The Rocket Propulsion Testing program supports a core of highly trained rocket test and engineering crews and test facilities. Finally, the Crew Health and Safety program provides oversight and accountability for the overall health and safety of NASA's astronaut corps.

OVERALL BUDGET:

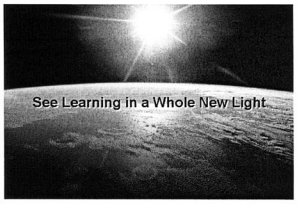
The FY 2006 request is $375.6 million. The budget includes:

- $69 million for Rocket Propulsion Testing (a five percent increase above FY 2005).
- $9 million for Crew Health and Safety (a 25 percent increase above FY 2005).

MAJOR ACTIVITIES PLANNED FOR FY 2006:

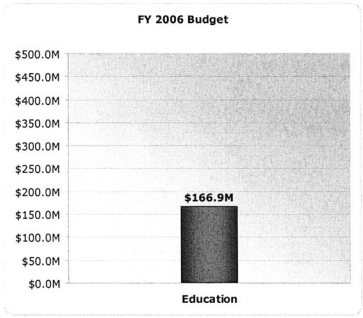
- Participate in technology demonstration of miniature Synthetic Aperture Radar/Communication integrated payload for the Chandrayaan-1 mission.
- Evaluate concepts to support Exploration Systems Mission Directorate timelines.
- Implement the Mission Operation Voice Enhancement Upgrade Project and the Space Network Expansion Project.
- Support Space Shuttle return to flight.
- Launch six primary payloads on Expendable Launch Vehicles.

Education

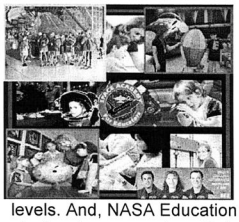


To develop the next generation of explorers, NASA must inspire and motivate students to pursue careers in science, technology, engineering, and mathematics. NASA's mission to understand and explore depends upon educated, motivated people with the ingenuity to invent tools and solve problems and with the courage to always ask the next question. It is not enough to depend on the excitement generated by images of NASA's achievements in space and on Earth; NASA must capitalize on that interest to provide meaningful education programs that will benefit the Agency and the Nation. To meet this challenge, education is a core part of NASA's mission, and education programs are an integral part of every major NASA activity.

NASA is working to ensure a pipeline of highly trained people prepared to meet mission requirements within NASA, as well as in industry and academia by: motivating students to pursue careers in science, technology, engineering, and mathematics; providing educators with unique teaching tools and compelling teaching experiences; ensuring that public resources are invested wisely; and fully engaging minority and under-represented students, educators, and researchers in NASA's education programs. The Office of Education will strive to reach, connect with, excite and inspire today's youth—the next generation of scientists, inventors, technicians, and explorers.



Education Programs



The Education Programs Theme will provide unique teaching and learning experiences through the Agency's research and flight missions. Students and educators will work with NASA and university scientists using real data to study Earth, explore Mars, and conduct scientific investigations. They will work with NASA engineers to learn what it takes to develop technological breakthroughs required to reach the farthest regions of the solar system and to live and work in space. To ensure diversity in NASA's future workforce, Office of Education programs will continue to pay particular attention to under-represented groups of students at all grade levels and economic levels. And, NASA Education programs will increase support to the Nation's universities providing challenging research and internship opportunities for qualified students, as well as a roadmap for students seeking NASA careers.

NASA FY 2006 Budget Request Summary

OVERALL BUDGET:

The FY 2006 request is $166.9 million:

- $28.4 million is requested for the Elementary and Secondary Education program to make available NASA-unique strategies, tools, content and resources supporting the K-12 education community's efforts that increase student interest and academic achievement in the science, technology, engineering, and mathematics (STEM) disciplines.
- $39.4 million is requested for the Higher Education program to attract and prepare students for NASA-related careers and to enhance the research competitiveness of the Nation's colleges and universities by providing opportunities for faculty and university-based research.
- $10.1 million is requested for the e-Education program to develop and deploy technology applications, products, services, and infrastructure that enhance the educational process for formal and informal education.
- $2.8 million is requested for the Informal Education program to bolster the informal education community efforts to inspire the next generation of explorers and enhance their capacity to engage in STEM education.
- $86.1 million is requested for the Minority University Research and Education program to prepare under-represented and under-served students for NASA-related careers, and to enhance the research competitiveness of minority-serving institutions by providing opportunities for faculty and university- and college-based research.
- Additional education-related funding is managed by NASA's Mission Directorates in coordination with the Office of Education.

Institutional Investments

As a function of full cost management, the following institutional investments are included in the preceding Mission Directorate budgets as either direct program charges or as Center or Corporate General and Administrative (G&A) charges. These areas are included in the summary below to document the resources provided for these activities.

Center G&A

Center G&A costs include Center security, ground maintenance, fire protection, business computing, public affairs, institutional construction of facilities, human resources, procurement, budgeting, etc. FY 2006 highlights include:

- Investing $1.5 billion in the critical Center infrastructure required to support the *Vision for Space Exploration*.

Center	FY 2006 ($ in millions)
Ames Research Center	191
Dryden Flight Research Center	40
Glenn Research Center	161
Goddard Space Flight Center	214
Johnson Space Center	207
Kennedy Space Center	232
Langley Research Center	195
Marshall Space Flight Center	226
Stennis Space Center	39
Total, Center G&A	**1,505**

Corporate G&A

Corporate G&A costs include Headquarters operations and Agency-wide functions. FY 2006 highlights include:

- $882 million total for FY 2006, as shown in the table below.
- $77 million for the Integrated Financial Management Program (IFMP) to continue improvement of NASA financial systems.
- $70 million for the Chief Information Office to provide tools and systems for efficient operations.
- $79 million for the NASA Engineering and Safety Center providing independent expertise to NASA's programs.
- $69 million for Environmental Compliance and Restoration supporting NASA's stewardship of government property.

Corporate G&A	FY 2006 ($ in millions)
Headquarters Corporate Activities	373
NASA Engineering and Safety Center	79
Corporate IFMP/HQ IFM	77
Chief Information Officer	70
Environmental Compliance and Restoration	69
Chief Engineer	53
Safety and Mission Assurance	52
Agency Operations	27
Independent Verification and Validation Facility	27
Advanced Planning and Integration	20
Center-Based Corporate G&A	11
Corporate CoF	10
Security Management	9
Chief Health and Medical Officer	5
Total, Corporate G&A	**882**

WORKFORCE

FY 2006 highlights include:

- $2.390 billion for salaries and benefits and $74.9 million for travel for 18,798 full time equivalent personnel. Salaries are included in G&A or program direct costs as appropriate.

CONSTRUCTION OF FACILITIES

FY 2006 highlights include:

$292.7 million for Construction of Facilities (CoF);

- $110.8 million for program direct CoF, carried in program budgets;
- $172.9 million for non-programmatic CoF, carried within Center G&A; and
- $9.0 million for a Facility Demolition initiative, carried within Corporate G&A, to remove unused buildings at the NASA field Centers.

ENVIRONMENTAL COMPLIANCE AND RESTORATION

FY 2006 highlights include:

- $69.1 million for environmental compliance, including $9.2 million for Plum Brook cleanup.
- Effective this fiscal year, Environmental Compliance and Restoration was transferred to Corporate G&A.

President's Management Agenda

In 2004, Office of Personnel Management Director Kay Coles James and Office of Management and Budget Deputy Director Clay Johnson, III, honored NASA as the first Federal agency to achieve the highest standards of excellence ("Green") in two of the original five government-wide President's Management Agenda (PMA) initiatives: (1) Strategic Management of Human Capital, and (2) Budget and Performance Integration. NASA also achieved "Green" in the PMA initiative of e-government. And, in December 2004, NASA was awarded a President's Quality Award in a third initiative, Competitive Sourcing. NASA's goal is to achieve "Green" ratings in all five PMA initiatives within three to four years. Like several other agencies, NASA also is working toward improvement in a new PMA initiative, Federal Real Property Management.

NASA's President's Management Agenda Scorecard (December 31, 2004)

	Human Capital	Competitive Sourcing	Financial Performance	E-Government	Budget and Performance Integration	Federal Real Property Management
Status*						
Progress						

Human Capital

NASA has implemented a human capital plan, established an accountability system to track the associated results, and demonstrated the ability to make distinctions in employee performance using a comprehensive awards system. NASA also has received Office of Personnel Management provisional certification in 2004 for its Senior Executive Service and SL/ST performance appraisal system.

Competitive Sourcing

NASA has a competitive sourcing plan and has announced two standard competitions involving more than 230 positions. Science competitions are an integral part of this plan enabling NASA scientists to compete against those in academia, industry, and other government agencies for research opportunities.

Financial Performance

NASA continues to face significant challenges in improving the quality of the Agency's financial reporting; however, NASA has an aggressive action plan and timetable to correct deficiencies. In 2003, NASA implemented the Core Financial Module of the Integrated Financial Management Program (IFMP) to standardize financial data and processes across Headquarters and the 10 NASA Centers. IFMP replaced 140 disparate legacy financial systems. Data reconciliation issues due to the conversion from the old to the new systems, however, presented challenges in preparing NASA's FY 2003 and FY 2004 financial statements.

e-Government

NASA has an information technology (IT) architecture in place to guide Agency investments and strengthen IT security. All NASA IT systems are now operating within 10 percent of planned budget and schedule. NASA is committed to implementing government-wide e-government solutions, such as the e-payroll system, which will improve the efficiency of government operations.

Budget and Performance Integration

NASA used performance information and full-cost considerations to develop the FY 2004, FY 2005, and FY 2006 budget requests and to support the Agency's management decisions. As noted, NASA was the first government agency to achieve a "Green" for this initiative.

Federal Real Property Management

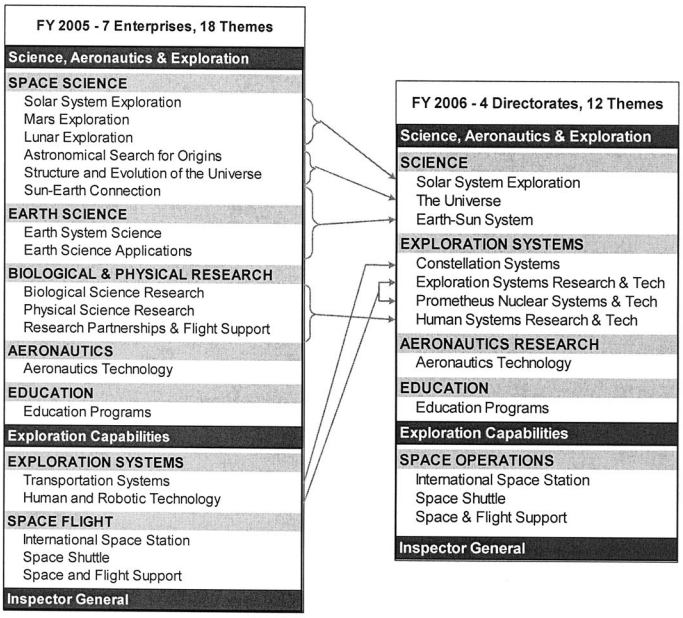
NASA is an active participant on the Federal Real Property Council, which supports government-wide best practices. The Agency currently is developing a comprehensive asset management plan to guide planning, acquisition, operation, and disposal of real property.

Budget Structure

NASA's budget is aggregated under three appropriation accounts: (1) Science, Aeronautics, and Exploration; (2) Exploration Capabilities; and (3) Inspector General. Under the first two accounts, the budget is organized according to Mission Directorates, NASA's primary areas of activity, and Themes, programmatic subdivisions of Mission Directorates that function as program "investment portfolios."

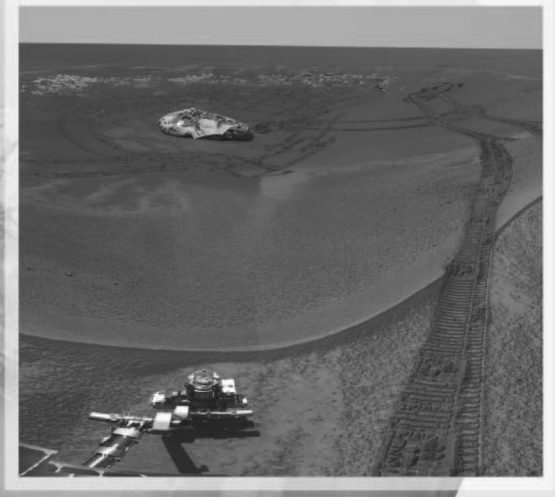
In response to the *Vision for Space Exploration*, supported by recommendations from the Aldridge Commission, NASA streamlined its budget structure from seven Enterprises with 18 Themes to four Mission Directorates and 12 Themes that align the Agency's resources with the *Vision for Space Exploration* while allowing for the flexibility NASA needs as it proceeds with the Agency's transformation. The new structure consolidates the Science Themes and more clearly delineates the Exploration Systems Themes. The Aeronautics activities are clearly defined as research, and the new structure continues to clearly identify NASA's Education activities.

Comparison of NASA's FY 2005 and FY 2006 Budget Structures



The New Age of Exploration

NASA's Direction for 2005 and Beyond



February 2005
National Aeronautics and Space Administration

NASA'S VISION

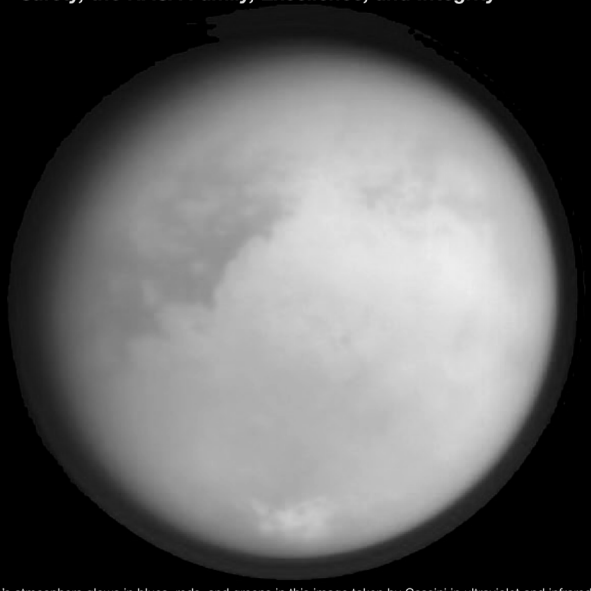
To improve life here,
To extend life to there,
To find life beyond.

NASA'S MISSION

To understand and protect our home planet,
To explore the universe and search for life,
To inspire the next generation of explorers
…As only NASA can.

NASA'S VALUES

Safety, the NASA Family, Excellence, and Integrity



Titan's atmosphere glows in blues, reds, and greens in this image taken by Cassini in ultraviolet and infrared wavelengths. The colors reveal a brighter (redder) northern hemisphere. Blue represents ultraviolet wavelengths and shows the high atmosphere and detached hazes.

Tragedy, Triumph, and Transformation

Reflection's from NASA Administrator Sean O'Keefe

President John F. Kennedy said, "All great and honorable actions are accompanied with great difficulties, and both must be enterprised and overcome with answerable courage." As I reflect on my three years at NASA, there have been moments of great tragedy and times of extraordinary triumph. I believe that we have sailed steadily through both, and along the way, we have begun to transform NASA and ourselves to meet the challenges of a new century.

Tragedy and Triumph

In 2003, the loss of Space Shuttle *Columbia* and seven astronauts stunned NASA and the world. The triumphant mission turned to tragedy in moments, and the shock and loss to our Agency were staggering. But, the NASA family was both determined to keep NASA's programs going and committed to returning the grounded Space Shuttle fleet to flight in tribute to our fallen comrades. Even as we mourned, we moved ahead.

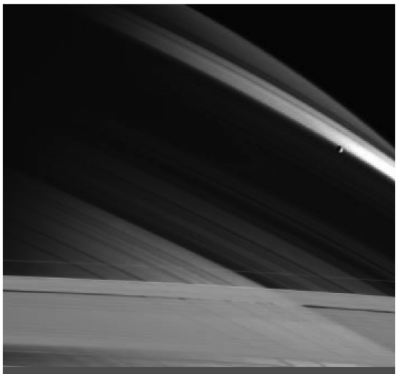
In 2004, we made excellent progress in implementing the recommendations of the *Columbia* Accident Investigation Board to return the Space Shuttle safely to flight. We also enjoyed and shared with the world a host of NASA triumphs. Our Mars rovers, *Spirit* and *Opportunity*, found definitive evidence of water on the Red Planet and continue to gather data more than a year after their successful landing. The Cassini–Huygens spacecraft entered Saturn's orbit and sent back breath-taking images of that planet's rings and moons. We launched MESSENGER to visit and map Mercury while our eyes in the sky, including Hubble, Chandra, and Spitzer, continued to amaze us with images from the deepest reaches of space. The X–43 flew nearly 10 times the speed of sound, and we enabled cleaner air, safer flights, and numerous technology transfers to other government agencies and private industry to improve the health, safety, and security of humankind. With our international partners, we made successful expedition missions to the International Space Station, completing four years of continuous human presence, and we added to our constellation of Earth observing satellites that monitor our fragile planet.

But, these triumphs were just the beginning.

The Vision for Space Exploration

On January 14, 2004, President George W. Bush announced *A Renewed Spirit of Discovery: The President's Vision for U.S. Space Exploration*, a new directive for the Nation's space exploration program. The fundamental goal of this directive is "…to advance U.S. scientific, security, and economic interests through a robust space exploration program." In issuing it, the President committed the Nation to a journey of exploring the solar system and beyond. We will return to the Moon in the next decade, then venture further into the solar system, ultimately sending humans to Mars and beyond. He challenged us to establish new and innovative programs to enhance our understanding of the planets, to ask new questions, and to answer questions that are as old as humankind. Our NASA family enthusiastically embraced this directive and the opportunities it presents. And, we immediately began a long-term transformation that will enable us to achieve this goal.

The *Vision for Space Exploration*, published in February 2004, embodies the strategy and guiding principles we will follow in pursuit of the President's challenge. And, while we have enjoyed many great triumphs during these three years, nothing in my time at NASA makes me more proud than our efforts to transform our Agency and implement the *Vision for Space Exploration*. This Vision defines us as those who seek to improve the human condition by expanding our knowledge and understanding of who we are, where we came from,



Saturn's moon Mimas is seen against the cool, blue-streaked backdrop of Saturn's northern hemisphere in this picture taken by the Cassini spacecraft in November 2004. Shadows cast by the rings streak across the planet.

and where we are going. It is not a random collection of great ideas. It is a plan that lays out fundamental goals of great importance for our Nation, and it embodies a strategy of specific milestones that will move us forward in the years and decades ahead if we are diligent in our pursuits.

In June 2004, the President's Commission on Implementation of the United States Space Exploration Policy (Aldridge Commission) presented its report to the President. The Commission emphasized the crucial role that technological innovation, national and international partnerships, and organizational transformation must play if we are to implement an affordable and sustainable space exploration program successfully. We are committed to making every change necessary to ensure our success.

Transformation

Transforming NASA requires that we take the extraordinary capabilities we have throughout the Agency and restructure them to achieve the goals of the 21st century. This has been a central challenge of our time together, but in less than a year, we have streamlined our Headquarters organization structure and begun transforming our culture to foster permanent change and effect a positive, mission-driven culture throughout the organization. Our senior leaders revalidated NASA's core values—Safety, the NASA Family, Excellence, and Integrity—and, to foster an environment of openness and free-flowing communication, we continue to assess our leadership practices and develop comprehensive individual leader action plans for greater effectiveness throughout. We also are cascading our values, goals, and objectives to every NASA employee through enhanced performance management strategies so the entire NASA family will be focused in the same direction.

The New Age of Exploration: NASA's Direction for 2005 and Beyond

As 2005 begins, our entire NASA family is focused on leading the Nation on a journey into the future with revitalized vigor and energy. The first step in that journey is to return the Space Shuttle to flight, a near-term goal that will enable us to complete assembly of the Space Station, and to move forward in understanding the challenges of long-duration space flight by returning humans to the Moon for an extended stay. From that experience, and all that we will learn, we will advance robotic and human exploration of Mars and other destinations throughout the solar system.

To manage what lies ahead as we implement the *Vision for Space Exploration*, we are making significant, on-going changes to our organization's planning processes. This document, *The New Age of Exploration: NASA's Direction for 2005 and Beyond*, is NASA's commitment to making those changes and to implementing the *Vision for Space Exploration*. *NASA's Direction for 2005 and Beyond* establishes new NASA Strategic Objectives. It aligns with our revised 2006 budget estimates, and we will reflect it in our *FY 2005 Performance and Accountability Report*.

Pending publication of the next NASA Strategic Plan, our Agency direction will be based on the following framework supporting the *Vision for Space Exploration*:

- NASA's overarching Agency goal is the fundamental goal of the *Vision for Space Exploration*—"…to advance U.S. scientific, security, and economic interests through a robust space exploration program."
- We will direct our efforts toward five National Objectives. Four of these come directly from the *Vision for Space Exploration*. The fifth National Objective affirms our continued commitment to understand and protect our home planet, Earth.
- We will pursue 18 long-term NASA Strategic Objectives to which all of our programs and resources will be tied.

Our 2006 NASA Strategic Plan will reflect this framework. It also will be based on a set of strategic and capability roadmaps currently being developed by national teams of experts from academia, industry, other government agencies, and NASA.

Stewards of the Dream

Seventeen billion visits to our Web site over the last year are just one indicator of how interested and supportive the American people are of America's space program. The NASA family is privileged to be the stewards of the people, to explore and discover on their behalf.

When Columbus made his voyages across the Atlantic in the 15th and 16th centuries, his ships carried the inscription, "Following the light of the sun, we left the old world." In our time together, we, too, sailed toward the light of the sun and left the old world behind. As I move on to other challenges, I wish everyone in the NASA family the very best of voyages to come.

NASA is a great organization that is positioned to approach and manage the future, whatever comes. I will continue to follow with pride NASA's journeys in the years to come with a full heart and the knowledge that I am a proud member of the extended NASA family.

Sean O'Keefe
Administrator

Pursuing National Objectives for Space Exploration

NASA's Guiding National Objectives

1. Implement a sustained and affordable human and robotic program to explore the solar system and beyond.
2. Extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations.
3. Develop innovative technologies, knowledge, and infrastructure both to explore and to support decisions about the destinations for human exploration.
4. Promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests.
5. Study the Earth system from space and develop new space-based and related capabilities for this purpose.

Astronaut Nancy Currie participates in a test with Robonaut, NASA's dexterous robotic assistant, to evaluate human–robotic operations. NASA is developing a wide range of autonomous robotics that will conduct surveys in advance of human exploration, offer astronauts an extra set of "hands and eyes," and conduct operations that would be hazardous to humans.

Pursuing National Objectives for Space Exploration

Like the pioneers of flight in the last century, NASA researchers and scientists cannot today identify all that the Nation will gain from space exploration in the future. They are confident, however, that the return on the Nation's investment will be great because the *Vision for Space Exploration* mandates a clear goal: "…to advance U.S. scientific, security, and economic interests through a robust space exploration program."

To ensure that NASA remains focused and achieves this goal, the Agency will direct all efforts and resources toward five National Objectives.

A Human and Robotic Partnership for Exploration

Humans are driven by a quest for profound knowledge: How did the universe and this solar system form? How and where did life begin? How far can humankind extend its reach into the universe? Is there life elsewhere? NASA's search for answers to these questions already has led to extraordinary scientific discoveries and technological breakthroughs that are benefiting humankind as well as the Nation's economy, security, and scientific prestige. These achievements also are fueling the drive to implement a sustained and affordable human and robotic exploration program that will carry explorers across the solar system and beyond.

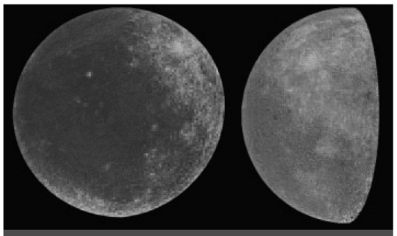
NASA views human and robotic explorers as partners in achieving the goal of the *Vision for Space Exploration*. Over the next three decades, NASA will send robotic missions to the Moon, Mars, the moons of Jupiter, and other planetary bodies in the outer solar system. These robotic explorers will visit new worlds to obtain scientific data, demonstrate technology capabilities, identify space resources, and gather information critical to maintaining the health and productivity of human explorers. Robotic missions also will serve as testbeds for developing and testing the technologies that eventually will carry human explorers beyond low Earth orbit. In short, robots will serve as counterparts to human explorers by offering an extra set of "hands and eyes," providing sensing capabilities that surpass human senses, going where humans cannot go, and bringing the universe back to Earth in the form of stunning images and samples of many kinds.

Human explorers ultimately will follow robotic explorers to elevate capabilities and accelerate discovery. As the President said, "We need to see and examine and touch for ourselves." Human explorers will provide unparalleled dexterity, versatility, breadth of knowledge and experience, and quick, logical decision-making capabilities to augment and complement robotic explorers. They also will serve as a potent symbol of American democracy, a reminder of what the human spirit can achieve in a free society.

To the Moon, Mars, and Beyond

Earth's closest planetary neighbor, the Moon, offers a wealth of important scientific data and a unique record of the early evolution of the solar system's terrestrial planets and near-Earth cosmic environments that existed during the first billion years of the solar system's history. This record is invaluable for reconstructing the period when the planets were formed. More important, by going to the Moon for extended periods of time, astronauts will learn how to work safely in an environment with low gravity, extreme temperatures, radiation, the absence of breathable air, and other conditions as a stepping stone to future planetary and space exploration. Explorers also will determine if the Moon can provide resources for sustained space exploration.

Recent robotic missions, including the Mars exploration rovers, *Spirit* and *Opportunity*, found evidence that Mars once had oceans and rivers of water—liquid water that might still exist in deep reservoirs. This evidence of water suggests that simple forms of life may have developed early in Mars' history and may persist beneath the surface today. Human exploration of Mars, including detailed geologic investigations, will enhance NASA's ability to achieve a key Agency mission: to search for life beyond Earth.



These false-color visualizations of the Moon taken by the Galileo spacecraft in 1990 depict the spectral properties of the lunar surface. The deeper blues show areas that are relatively rich in titanium, while the greens, yellows and light oranges indicate basalts low in titanium but rich in iron and magnesium. The reds (deep orange in the right hand picture) are typically cratered highlands relatively poor in titanium, iron and magnesium. NASA will conduct extensive surveys of the Moon to locate resources and determine the best landing sites for other robotic or human surface missions.

Challenging Technology Innovation

The Apollo, Space Shuttle, and International Space Station programs identified technical challenges to long-duration space exploration that must be overcome through new technologies that support reasoned decision-making about future exploration destinations and the feasibility, methodologies, and risks associated with space exploration. New technologies must ensure that subsystems are reusable and modular, require less ground support and infrastructure, and be compatible with enhanced in-space assembly and repair capabilities. These innovative technologies will include robotic networks that can work cooperatively, cost-effective power generators for long duration missions, enhanced space communication technologies that address the needs of spacecraft operating in both near-Earth and deep-space regions, and methodologies for achieving precise, reliable, and global access to the Moon and other destinations from orbit and from other planetary surfaces through the use of advanced mobility systems.

Promoting Partnerships

Exploration and discovery fuel economic, social, and intellectual growth and accelerate the development of science and technologies that are important to the world's economy and national security. Partnerships provide opportunities to leverage resources. They create venues for research and technology to be matured and transferred to government and private entrepreneurs, and they provide unparalleled educational opportunities. Together, NASA and the Agency's partners can accomplish more than any one entity could achieve alone.

NASA has a long history of collaboration with the space and research agencies of other nations. The International Space Station draws on the resources and scientific and engineering expertise of 16 nations. Since the Space Shuttle was grounded after the *Columbia* accident in February 2003, automated Russian Progress vehicles have re-supplied the two-person Station crew as needed, and Russian Soyuz vehicles have transported crews safely and reliably to and from the Station. A similarly extraordinary international partnership with Europe contributed to the success of the Cassini–Huygens mission to Saturn, and the SOHO mission to observe the Sun. In fact, nearly all NASA Earth observing missions include substantial international participation. For example, the Global Earth Observation System of Systems includes over 50 nations and more than 30 international research and environmental forecasting organizations. And, NASA also participates actively in international groups like the International Civil Aviation Organization, which develops global policies governing commercial flight.

NASA's partnerships with other government agencies have advanced science and research and ensured that technologies emanating from NASA's work are transferred to organizations that can use them for the benefit of all. From sharing NASA satellite air quality data with the Environmental Protection Agency, developing new technologies for safer flight with the Federal Aviation Administration, identifying biological contaminants for the Department of Homeland Security, to sharing information and leveraging resources with the Department of Defense, NASA is a full Federal partner in exploration and discovery initiatives. State and local governments, too, rely on and support NASA's work, perhaps most prominently in education and environmental improvements. NASA continues to seek opportunities to establish new government partnerships while maintaining existing alliances.

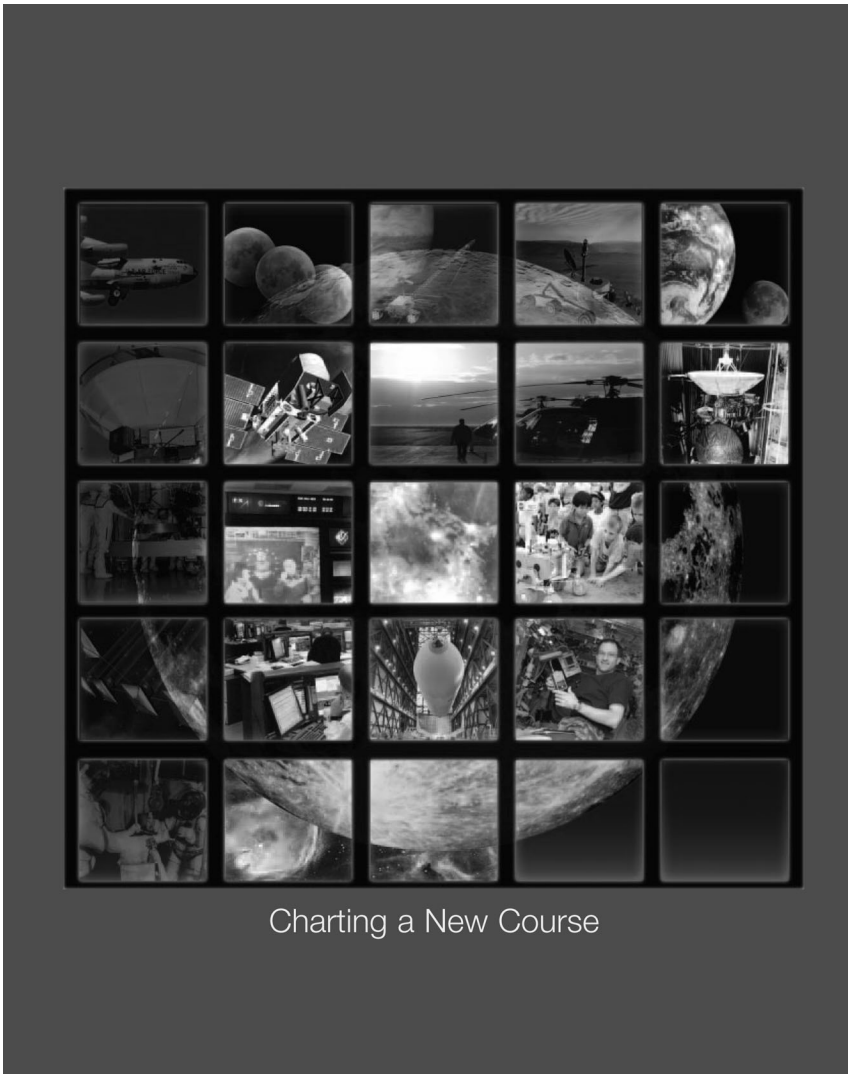
NASA also has a long history of working with the Nation's education community at all levels. From awarding grants, supporting fellowships and university research consortia, and conducting research at the Nation's top universities to engaging the next generation of explorers and researchers in mathematics and science classrooms everywhere, NASA provides scientific content, advanced technological tools, and supplemental educational services as part of an education pipeline that extends from elementary through secondary education and beyond. NASA also partners with national, state, and local teacher and education associations and Boards of Education to meet the needs of teachers and students.

NASA's partnerships with industry have resulted in many of the discoveries and milestones in NASA's history. While NASA benefits from the expertise, materials, and components provided by large and small companies, the Agency's partner industries benefit economically from collaborating with NASA. Industrial partnerships also encourage healthy competition, demonstrate and enhance the appropriate role of the Federal government, and often provide economic benefits to small and disadvantaged businesses.

Focusing On Earth

Throughout the last several decades, NASA has used space technology to understand Earth, the Sun, and the powerful links between the two. Using space-based observations, the Agency provided essential data enabling scientists to learn how the El Niño–La Niña cycle works, gain new insights into Antarctic ozone depletion, track the dramatic decrease in sea ice cover in Earth's Arctic region, and characterize the present state of the Earth–Sun system. Having pioneered space-based remote sensing, NASA and its partners recently completed deployment of the first comprehensive Earth Observing System, and NASA's goal is to continue using the view from space to study the Earth system and improve prediction of Earth system changes.

NASA will develop new space-based technology to monitor the major interactions of the land, oceans, atmosphere, ice, and life that comprise the Earth system. In the years ahead, NASA's fleet will evolve into human-made constellations of smart satellites that can be reconfigured based on the changing needs of science and technology. From there, researchers envision an intelligent and integrated observation network comprised of sensors deployed to vantage points from the Earth's subsurface to deep space. This "sensorweb" will provide timely, on-demand data and analysis to users who can enable practical benefits for scientific research, national policymaking, economic growth, natural hazard mitigation, and the exploration of other planets in this solar system and beyond.



Charting a New Course

NASA STRATEGIC OBJECTIVES FOR 2005 AND BEYOND

1. Undertake robotic and human lunar exploration to further science and to develop and test new approaches, technologies, and systems to enable and support sustained human and robotic exploration of Mars and more distant destinations. The first robotic mission will be no later than 2008.
2. Conduct robotic exploration of Mars to search for evidence of life, to understand the history of the solar system, and to prepare for future human exploration.
3. Conduct robotic exploration across the solar system for scientific purposes and to support human exploration. In particular, explore the moons of Jupiter, asteroids, and other bodies to search for evidence of life, to understand the history of the solar system, and to search for resources.
4. Conduct advanced telescope searches for Earth-like planets and habitable environments around the stars.
5. Explore the universe to understand its origin, structure, evolution, and destiny.
6. Return the Space Shuttle to flight and focus its use on completion of the International Space Station, complete assembly of the ISS, and retire the Space Shuttle in 2010, following completion of its role in ISS assembly. Conduct ISS activities consistent with U.S. obligations to ISS partners.
7. Develop a new crew exploration vehicle to provide crew transportation for missions beyond low Earth orbit. First test flight to be by the end of this decade, with operational capability for human exploration no later than 2014.
8. Focus research and use of the ISS on supporting space exploration goals, with emphasis on understanding how the space environment affects human health and capabilities, and developing countermeasures.
9. Conduct the first extended human expedition to the lunar surface as early as 2015, but no later than 2020.
10. Conduct human expeditions to Mars after acquiring adequate knowledge about the planet using robotic missions and after successfully demonstrating sustained human exploration missions to the Moon.
11. Develop and demonstrate power generation, propulsion, life support, and other key capabilities required to support more distant, more capable, and/or longer duration human and robotic exploration of Mars and other destinations.
12. Provide advanced aeronautical technologies to meet the challenges of next generation systems in aviation, for civilian and scientific purposes, in our atmosphere and in atmospheres of other worlds.
13. Use NASA missions and other activities to inspire and motivate the Nation's students and teachers, to engage and educate the public, and to advance the scientific and technological capabilities of the nation.
14. Advance scientific knowledge of the Earth system through space-based observation, assimilation of new observations, and development and deployment of enabling technologies, systems, and capabilities, including those with the potential to improve future operational systems.
15. Explore the Sun–Earth system to understand the Sun and its effects on Earth, the solar system, and the space environmental conditions that will be experienced by human explorers, and demonstrate technologies that can improve future operational systems.
16. Pursue opportunities for international participation to support U.S. space exploration goals.
17. Pursue commercial opportunities for providing transportation and other services supporting International Space Station and exploration missions beyond Earth orbit. Separate to the maximum extent practical crew from cargo.
18. Use U.S. commercial space capabilities and services to fulfill NASA requirements to the maximum extent practical and continue to involve, or increase the involvement of, the U.S. private sector in design and development of space systems.

Charting a New Course

This generation inherited great legacies from the exploratory voyages and discoveries of earlier centuries, and NASA's success in achieving the *Vision for Space Exploration* will bequeath to future generations a similar legacy of achievement and inspiration. Because the purpose of exploration is to understand the unknown, the precise benefits of space exploration defy calculation, and planning must remain fluid and dynamic to adapt to exciting diversions and new directions. To ensure that NASA pursues the *Vision for Space Exploration* in a systematic, yet flexible manner, the Agency has established 18 NASA Strategic Objectives to guide the Agency's course in 2005 and beyond. The first 15 are related directly to NASA program initiatives, and a specific Mission Directorate will champion each. The final three are cross-cutting support objectives. They do not have unique performance measures or budgets. However, their successful achievement is critical to NASA's achievement of the *Vision for Space Exploration*.

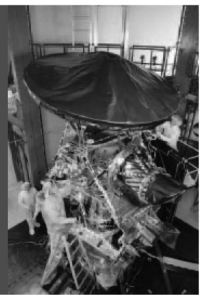
Strategic Objective 1: Undertake robotic and human lunar exploration to further science and to develop and test new approaches, technologies, and systems to enable and support sustained human and robotic exploration of Mars and more distant destinations. The first robotic mission will be no later than 2008.

As a stepping-stone to Mars and beyond, NASA's first destination for robotic and human exploration is the Moon. Only a few days from Earth, the Moon contains a 4.5 billion-year record of the origin of the Earth-Moon system and the processes that formed the inner planets. It also provides a convenient location in which to develop and test a variety of exploration tools and techniques. NASA will advance lunar science and use the Moon to: test and develop hardware, software, and various systems and components to determine how they operate in harsh lunar and space environments; provide the opportunity to understand how crews adapt and perform in a partial-gravity environment; test the autonomy of essential systems before they are deployed to more distant destinations; test and enhance interactions between human explorers and robots; and explore the possibility of using resources already present on the Moon for power generation, propulsion, and life support. NASA will begin its lunar research and testbed program with a series of robotic missions beginning with a Lunar Reconnaissance Orbiter to be launched in 2008.

Strategic Objective 2: Conduct robotic exploration of Mars to search for evidence of life, to understand the history of the solar system, and to prepare for future human exploration.

The presence of liquid water is the key to the presence of life beyond Earth. The Mars Exploration Rovers, *Spirit* and *Opportunity*, recently found evidence that water had been present on the Red Planet—in the rocks and soil on the floor of Gusev crater and in standing pools of water that once existed in Meridiani Planum. Based on these discoveries, NASA will pursue the search for water and life on Mars aggressively. NASA's robotic explorers will discern the evolution of Mars and characterize the Red Planet, including its past and present geology, interior, climate, environment, and its biological potential. From this information, NASA will determine the habitability of Mars and determine whether it has ever harbored life.

NASA's exploration of Mars involves a methodical succession of orbiting and surface laboratories over the next two decades in preparation for future human missions. The Mars Global Surveyor and Mars Odyssey, two currently operational orbiters, have improved estimates of the abundance of water within the uppermost surface layer, atmosphere, and icecaps of Mars. Odyssey is measuring the galactic cosmic radiation background from Mars's orbit, and it is likely that solar and cosmic radiation measurements will be conducted from the Mars surface later in the decade. The Mars Reconnaissance Orbiter, to be launched this year, will use subsurface sounding radar to search below the surface of Mars for evidence of water. The Orbiter also will characterize atmospheric processes over a full Mars year and provide



Crews work on the Mars Reconnaissance Orbiter, which is scheduled to launch in summer 2005. In this photo, taken in January 2005, the Orbiter has already been fitted with five of its six primary science instruments, both solar arrays, and its high-gain antenna. The Orbiter will begin a series of global mapping, regional survey, and targeted observations from a near-polar, low-altitude orbit, analyzing minerals and searching the shallow subsurface for water.

The solar system's largest moon, Ganymede, is shown alongside Jupiter in this picture taken by the Cassini spacecraft in 2000. Cassini arrived at its primary target, Saturn, in 2004.

the first definitive measurements of local mineralogy in the search for possible habitats for life.

In 2007, the Phoenix Mars Scout mission will land at Mars' ice-rich northern latitudes to measure climate, chemistry, and organics. Subsequently, the 2009 Mars Science Laboratory will start a series of missions to explore a vast terrain on Mars' surface for evidence of organic materials and other signatures of past and present life, returning samples for study in Earth laboratories. By the end of the next decade, NASA will have a complete inventory of critical environmental parameters, local hazards, and potential resources to support future human exploration of Mars.

Strategic Objective 3: Conduct robotic exploration across the solar system for scientific purposes and to support human exploration. In particular, explore the moons of Jupiter, asteroids, and other bodies to search for evidence of life, to understand the history of the solar system, and to search for resources.

In the coming decades, spacecraft will fan out to destinations from the innermost planets to the edge of the Sun's influence to learn more about the history of the solar system and search for signs of life and usable resources. NASA's Discovery Program will continue to support highly focused missions that are a key element of the Agency's current and future exploration program. Discovery Program missions have included: the Mars Pathfinder and Lunar Prospector missions; the recent Genesis mission that returned samples of solar winds to Earth; and the MESSENGER mission launched in August 2004 to conduct a comprehensive geological, geophysical, and geochemical survey of Mercury. The Deep Impact mission will investigate volatile and organic materials in the deep interior of a short-period comet to determine if comets might have transported water to Earth from the outer reaches of our solar system. Stardust—a longer-term Discovery mission—will return comet dust samples to Earth in 2006, and Dawn will visit the two largest asteroids to shed light on the formation of the solar system.

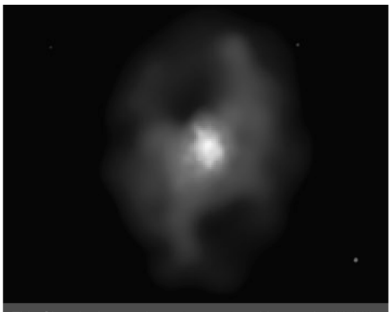
Other missions are long-term and more complex, such as long-duration exploration of the outer planets and their moons. The twin Voyager spacecraft and Galileo found evidence that planet-wide oceans likely lie beneath the icy surfaces of Jupiter's moons, particularly Europa, suggesting that life could have developed—and might still exist—on one or more of these moons today. The exploration of Europa was identified as the highest "flagship" mission in the National Research Council's 2003 solar system decadal study, *New Frontiers in the Solar System: An Integrated Exploration Strategy*.

As part of the New Frontiers program, a mission to Pluto in 2006 will examine the Pluto–Charon system and Kuiper Belt, which may retain the best records of the materials present in the original solar nebula. The planets, moons, and ancient icy bodies that reside far from the Sun are thought to be a repository of relatively pristine materials from this time and, therefore, hold keys that can help unlock the mysteries of the solar system's origins.

Strategic Objective 4: Conduct advanced telescope searches for Earth-like planets and habitable environments around the stars.

Thanks to NASA's eyes in the sky, including Hubble, Chandra, and Spitzer, over the past decade, astronomers discovered and documented well over 100 extra-solar planets, new worlds, and the discovery that the Sun is not the only star anchoring a solar system, giant steps forward in the search for extraterrestrial life. Within this decade, NASA will launch powerful space-based telescopes that can infer the presence of newly-formed planets circling young stars, count the planets around thousands of far-off stars, and detect planets just a few times larger than Earth orbiting nearby stars. The Space Interferometry Mission will be capable of detecting and measuring the mass of near Earth-sized planetary bodies orbiting nearby stars. The Kepler mission, planned for launch in 2007, will provide the first opportunity to learn how common it is for a star to have an orbiting Earth-sized planet. And, the James Webb Space Telescope, a large, infrared telescope, will be launched in 2011 to study the earliest galaxies and stars.

The results from these telescopes will be factored into the design of an advanced space telescope, the Terrestrial Planet Finder, to be launched in the next decade. The Terrestrial Planet Finder will be capable of finding Earth-like planets and detecting the chemical composition of their atmospheres. If NASA finds terrestrial planets orbiting nearby stars, the Agency can tackle two even more ambitious objectives: determining which planets have conditions suitable for life and which, if any, show actual signs of past or present life.



This Chandra image shows two vast cavities, each 600,000 light years in diameter, in the hot, X-ray emitting gas that pervades the galaxy cluster MS 0735. The cavities appear on opposite sides of a large galaxy at the center of the cluster, which indicates that a gigantic eruption produced by the galaxy's supermassive black hole created the structures. The next generation of X-ray observatories will be far more powerful than Chandra, revealing structuers in the universe that are currently hidden.

Strategic Objective 5: Explore the universe to understand its origin, structure, evolution, and destiny.

In their attempts to understand how space, time, and matter are connected, Albert Einstein and his successors made three predictions based on their research. First, space is expanding from a "Big Bang." Second, space and time can tie themselves into contorted knots called "Black Holes" where time actually comes to a halt. And, third, space itself contains some kind of energy that is pulling the universe apart. Today, scientists strongly believe that all three are true. Still, Einstein's theories raised more confounding questions: What powered the "Big Bang"? What happens to space, time, and matter at the edge of a black hole? And, what is the mysterious dark energy that is pulling the universe apart? NASA researchers are leading the way to answering these compelling questions.

Gravity Probe B, launched in 2004, is testing Einstein's prediction that the rotation of the Earth drags space and time around the Earth into a mild version of the tremendous vertical spin near a spinning black hole. The Swift Explorer, also launched in 2004, will study gamma ray bursts believed to result from the stellar explosions and mergers that create black holes. And, the Gamma-ray Large Area Space Telescope (GLAST) will measure gamma rays emitted by a variety of energetic objects like quasars, galaxies in which large quantities of gas are falling onto a super-massive black hole that occupies the galaxy center, releasing huge amounts of gravitational energy. GLAST will map the sky in one day—a task that previously took one year to complete.

As part of NASA's Beyond Einstein program, a pair of great observatories will blaze new paths to answer old questions about black holes, the "Big Bang," and dark energy. First, the Laser Interferometer Space Antenna will probe space and time at the forming edges of black holes by listening to the sounds of vibrating space-time. It will measure gravitational radiation generated by a variety of astrophysical phenomena, including the effect of dark energy on the universe. Next, Constellation X (with 100 times the sensitivity of the Chandra X-ray Observatory) will measure X-ray light resulting from the motions of the plasma and distortions of space and time near the black hole. It will reveal the nature of dark matter and dark energy by observing their effects on the formation of clusters of galaxies. In addition, a number of medium-size missions will focus on understanding dark energy, dark matter, and the cosmic background.

Strategic Objective 6: Return the Space Shuttle to flight and focus its use on completion of the International Space Station, complete assembly of the ISS, and retire the Space Shuttle in 2010, following completion of its role in ISS assembly. Conduct ISS activities consistent with U.S. obligations to ISS partners.

The Space Shuttle's chief purpose over the next several years will be to support assembly of the International Space Station.

Space Shuttle *Discovery* is being readied for return to flight this year, and all three orbiters are going through processing at NASA's Kennedy Space Center where enhanced safety modifications are being made to the Shuttle's external tanks and Thermal Protection Systems. When *Discovery* lifts off, it will have a new multi-functional electronic display system, also called a "glass cockpit," and enhanced vehicle monitoring during flight, including 88 wing leading-edge sensors to monitor acceleration, impact, and temperature, and a digital

Crews slowly moved an External Tank into the awaiting arms of a transporter in the Vehicle Assembly Building at Kennedy Space Center in October 2004. The Tank then was transferred to NASA's Michoud Assembly Facility in New Orleans, where its foam was replaced with an improved bipod fitting. Afterward, the External Tank was returned to Kennedy, where it waits for return to flight.

camera to document the external tank as it separates from the Shuttle.

The International Space Station is the largest international cooperative science and technology project in which the United States has been involved. When complete, it will support robust research by all partner nations through at least 2016. NASA will complete assembly of the International Space Station by the end of the decade. The Agency is examining configurations for the Space Station that meet the needs of both the *Vision for Space Exploration* and NASA's international partners using as few Shuttle flights as possible. This assessment is critical to allowing NASA to continue work on Space Station assembly safely and retire the Shuttle as planned to make way for the Crew Exploration Vehicle (CEV).

In 2010, the Space Shuttle—after nearly 30 years of service—will be retired.

Strategic Objective 7: Develop a new crew exploration vehicle to provide crew transportation for missions beyond low Earth orbit. First test flight to be by the end of this decade, with operational capability for human exploration no later than 2014.

NASA will develop a new CEV to transport crews beyond low Earth orbit and back again. The CEV will be designed to serve multiple functions and operate in a variety of environments. The overall crew transportation system that will evolve from the basic CEV design will enable ascent and re-entry into Earth's atmosphere, Earth orbit, transit to deep space, and operations at the Moon, Mars, or other exploration sites. Initial high-level milestones for this project include, a CEV demonstration flight in 2008 to validate key CEV systems and subsystems, a CEV flight without crew in 2011, and a CEV flight with crew in 2014.

Expedition 10 Commander and Science Officer Leroy Chiao exercises with the short bar for the Interim Resistive Exercise Device to help maintain his upper body strength. NASA is using the Station to develop and test countermeasures, such as exercise techniques, to keep astronauts healthy during long-duration space flight.

Strategic Objective 8: Focus research and use of the ISS on supporting space exploration goals, with emphasis on understanding how the space environment affects human health and capabilities, and developing countermeasures.

After the Space Shuttle returns to flight and major research facilities are delivered to the International Space Station, the Station will emerge as a unique platform for conducting experiments related to human health and performance and developing and testing life support technologies. Larger Station crews will enable a greater range and frequency of operations. NASA will test countermeasures to compensate for the effects of space on human physiology, and astronauts will use the Station to practice autonomous medical care that will be essential for human exploration far from Earth. At the same time, NASA will use the Station to evaluate the performance in microgravity of selected new components, subsystems, and systems necessary for advanced life support.

Astronauts use drilling equipment in this artist concept of future lunar exploration. The ability to use in-situ resources is a key capability for future human lunar and planetary missions.

By 2008, researchers will conduct ground- and flight-based studies that support the development of measures to prevent or minimize microgravity-induced bone loss and muscle atrophy. NASA research on radiation will focus on establishing acceptable levels of risk to crew members, improving the models used to predict radiation levels and effects, and developing implementation strategies for operational countermeasures, including radiation shielding, nutritional supplements, and pharmacological intervention. By 2008, NASA will reduce the uncertainties in estimating radiation risk by one-half and demonstrate the feasibility of radiation-shielding multifunctional structures. In addition, NASA will develop advanced life support systems with reduced size, weight, and complexity that require less power and can save consumables. The Agency also will develop advanced extra-vehicular activity systems, including a protective suit optimized for use on planetary surfaces. By 2010, NASA will identify, develop, and test technologies to reduce total mass requirements for life support systems. The Agency also will devel-

op by 2010 systems to enable production of life support consumables from simulated available resources.

Strategic Objective 9: Conduct the first extended human expedition to the lunar surface as early as 2015, but no later than 2020.

NASA will return humans to the Moon by developing the technological capabilities necessary to sustain extended human space exploration. These capabilities include the critical system-of-systems that will encompass robotic orbiters and rovers, crew transportation, cargo transportation, surface exploration vehicles, in-space and ground support, and other technologies. The development process will include a wide range of technology and systems demonstrations, therefore NASA is using a competitive process with industry-led teams submitting proposals to develop and test different concepts.

Strategic Objective 10: Conduct human expeditions to Mars after acquiring adequate knowledge about the planet using robotic missions and after successfully demonstrating sustained human exploration missions to the Moon.

NASA will determine when to conduct the first human mission to Mars based on numerous criteria, including: discoveries from robotic Mars missions and long-duration human exploration of the Moon; technology readiness (e.g., utilization of in-situ resources, demonstrations of habitat prototypes, improved in-space assembly and repair capabilities, and extended power generation); the ability to sustain healthy, productive crews in the hazardous Martian environment; and available resources. In addition, NASA will consider the effectiveness and readiness of ground/surface operations and supporting systems prior to conducting a human expedition to Mars.

Exploration of other planets may involve winged flight vehicles, such as this Mars flyer concept, to bridge the capabilities gap between orbital and surface vehicles. NASA is researching how to design vehicles that operate in different and unique environments.

Tucked under the wing of NASA's B–52B aircraft, the X–43 hypersonic research vehicle performed a captive carry evaluation flight on September 27, 2004. It is powered by a revolutionary supersonic-combustion ramjet, or "scramjet." Inset: The X–43's rocket ignited moments after release from the B–52B, setting the vehicle on a record-setting flight where it reached nearly Mach 9.8 (7,000 miles an hour). NASA is developing scramjet technology to carry vehicles from Earth to orbit without the heavy oxygen tanks carried by currently-used launch vehicles. Credit: large photo, T. Tschida.

Strategic Objective 11: Develop and demonstrate power generation, propulsion, life support, and other key capabilities required to support more distant, more capable, and/or longer duration human and robotic exploration of Mars and other destinations.

NASA will transform the Agency's space exploration capabilities by investing resources in technical challenge areas, including high-energy power and propulsion; in-space transportation; advanced telescopes and observatories; communication and navigation; robotic access to planetary surfaces; human planetary landing systems; human health and support systems; human exploration systems and mobility; autonomous systems and robotics; transformational spaceport/range; scientific instruments/sensors; in-situ resource utilization; advanced modeling, simulation, and analysis; systems engineering cost/risk analysis; and nanotechnology.

A major focus of NASA's current research is in-space use of nuclear power to meet the higher power needs of future missions. NASA and the Department of Energy are advancing NASA's nuclear systems program, Project Prometheus, cooperatively. NASA researchers hope that enhanced power systems will enable future spacecraft to use instruments of greater sensitivity and resolution than those carried on other missions to distant planets. These advanced instruments would include high-powered radar to penetrate deep into the sub-surfaces of planets and moons, more capable cameras to map entire moons, and laser technology to measure topography. Once proven for in-space use, these nuclear systems also would be used to supply power, and perhaps propulsion, that would reduce travel time to the Moon and other planets.

Educator astronaut Barbara Morgan interacts with students at an Explorer School. Educator astronauts are the direct link between NASA and students, sharing the excitement of discovery with the next generation of scientists, engineers, and explorers.

These same nuclear technologies also would provide energy sources for tools, instruments, and lunar and planetary surface roving vehicles to enable extended human and robotic operations.

Strategic Objective 12: Provide advanced aeronautical technologies to meet the challenges of next generation systems in aviation, for civilian and scientific purposes, in our atmosphere and in atmospheres of other worlds.

For almost 80 years, NASA and its predecessor agency have helped define today's aircraft and promote the rapid growth of aviation through innovation and advanced technology. Today, air transportation is crucial to the Nation's economic health, national security, and overall quality of life, but the U.S. air transportation system is reaching the limits of its capacity and facing new challenges in maintaining safety, security, and a healthy environment. To overcome these problems, NASA is pursuing advanced technologies that will increase air system safety and security, reduce aircraft noise and emissions, and increase the capacity and efficiency of the National Airspace System.

Compared to the 1997 baseline, NASA's technology innovation goals in aeronautics will enable significant improvements in aviation over the next several years: a 70-percent reduction in the aircraft fatal accident rate by 2010; doubling the National Airspace System's capacity by 2009; and a 10-decibel reduction in aircraft noise by 2009. NASA technologies also will reduce the National Airspace System vulnerability by 35 percent compared to 2003.

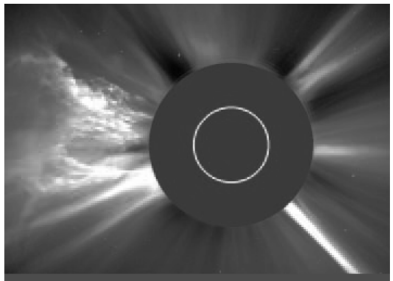
More important, however, the current market is forcing transformation in all major facets of the National Airspace System: aircraft systems, ground and air operations, automation and control, and how transportation modes (e.g., plane, car, truck, rail) come together to maximize the System's efficiency and capacity. The transformation options are complicated, and the implementation risks are high. The Federal government's role in this context will be to enable necessary changes and lessen the negative impacts evidenced by increased restructuring of airlines, disruption of services, and reduction in benefits and stability for airline workers. Dealing effectively with this transformation requires organizations that can provide impartial and multi-faceted capabilities in areas like capacity, safety, and systems research and development, and that can negotiate and co-develop solutions with industry, academia, other government agencies, as well as the international community. NASA is a unique organization capable of meeting these demands.

Strategic Objective 13: Use NASA missions and other activities to inspire and motivate the Nation's students and teachers, to engage and educate the public, and to advance the scientific and technological capabilities of the nation.

NASA will continue to inspire and motivate the next generation of explorers through the Agency's visible research, enabling technologies, and exciting discoveries. As noted by the Aldridge Commission, the *Vision for Space Exploration* offers "an extraordinary opportunity to stimulate mathematics, science, and engineering excellence for America's students and teachers." To achieve this goal, education programs are an integral part of every major NASA activity.

NASA has initiated and/or enhanced many activities, including: working with governments, industries, and professional organizations to integrate science, technology, engineering, and mathematics education initiatives, internships, and other activities into training and development programs and outreach initiatives; creating a university-based "virtual space academy" to train the next generation of technical workforce; and fully implementing the NASA Explorer Schools program and the NASA Educator Astronaut program. NASA's Science and Technology Scholarship Program links scholarships with service at NASA Centers to help the Agency attract top students to the workforce, and NASA Explorer Institutes initiative links NASA to the informal education

The Terra satellite imaged this phytoplankton bloom off the coast of Argentina in January 2005. Terra is one of several NASA Earth observation satellites that provide a comprehensive view of Earth's system, from the surface to the upper atmosphere. Additional satellites, including Cloudsat and Calipso, will enhance current observation capabilities.



The SOHO spacecraft imaged three significant coronal mass ejections in late December 2004. Coronal mass ejections bombard Earth with energetic particles, disrupting electronics and communications and exposing astronauts in Earth orbit to higher levels of radiation. NASA is finding ways to better predict space weather and to prepare for violent space weather events that could pose a threat to astronauts in space and technology on Earth.

community—science centers, museums, planetaria, and other organizations. NASA also works actively with industry, professional organizations, and the media to engage the public in understanding why space exploration is vital to America's scientific, economic, and security interests.

NASA also is increasing the priority of, and emphasis on, teacher training by providing for teachers the tools they need today to teach the Nation's researchers and explorers of tomorrow. With its partners, the Agency is creating extraordinary technology enhancements that will make learning more available and exciting for all students, including those with auditory, visual, physical, and intellectual challenges. These technologies will help students, educators, families, and individuals around the world explore new worlds of learning while pursuing their own journeys of personal discovery.

Strategic Objective 14: Advance scientific knowledge of the Earth system through space-based observation, assimilation of new observations, and development and deployment of enabling technologies, systems, and capabilities, including those with the potential to improve future operational systems.

NASA's ability to study Earth from space has given humanity new tools with which to understand and protect their home planet. Having completed the first phase of the Earth Observing System, the Agency is extracting scientific knowledge of the Earth's carbon, water, and energy cycles from the system's data and sharing the information with NASA's partner Federal agencies like the National Oceanic and Atmospheric Administration, the Federal Emergency Management Agency, the Federal Aviation Administration, and the Environmental Protection Agency, enabling them to provide essential services to the Nation.

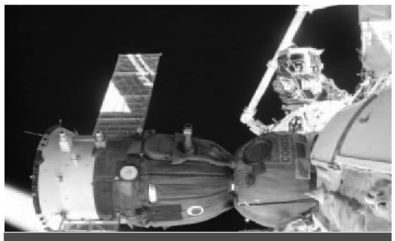
NASA already is moving to develop and deploy the next generation of Earth observing capabilities. In 2005, Cloudsat and CALIPSO will add their innovative three-dimensional view to the existing satellites to form the "A-train" of observers, providing a complete picture of Earth's atmosphere. A new slate of NASA satellites capable of measuring atmospheric carbon dioxide, soil moisture, and ocean surface salinity and topography will be the next wave of climate change research capabilities. Ultimately, NASA and the Agency's partners will create an integrated "sensorweb" of satellites in low, medium, and higher orbits to enhance scientists' abilities to predict climate, weather, and natural hazards. For example, working with the Agency's American and international partners, NASA will develop predictive capabilities within the next 10 years that will enable: 10-year or longer climate forecasts; three-day air quality forecasts for ozone and aerosols; 10- to 100-year forecasts of carbon dioxide and methane concentrations with greater than 50-percent improvement in confidence; seasonal precipitation forecasts with greater than 75-percent accuracy at tens of kilometers of resolution; and seven to 10-day weather forecasts with 75-percent accuracy.

NASA's unique view of the world from space is essential to the continued success of the Climate Change Research program, the Global Earth Observation program. NASA will continue advancing the Nation's use of this view to enhance economic, security, and environmental stewardship and, in so doing, demonstrate techniques for studying a planet in its entirety—techniques that researchers can employ in the future to explore other planetary bodies and conduct the search for life beyond Earth.

Strategic Objective 15: Explore the Sun-Earth system to understand the Sun and its effects on Earth, the solar system, and the space environmental conditions that will be experienced by human explorers, and demonstrate technologies that can improve future operational systems.

Life on Earth prospers in a biosphere sustained by energy from the Sun, but powerful flares and coronal mass ejections arriving at Earth can disrupt telecommunications and navigation, threaten astronauts, damage satellites, and disable electric power grids. As society becomes increasingly dependent on space-based technologies, the vulnerability to space weather effects on Earth, and on other planets, becomes more apparent, and the need to understand and mitigate its effects becomes more urgent. NASA's goal is to understand the causes of space weather by studying the Sun, the heliosphere, and planetary environments as a single, connected system. This will be achieved by pursuing two groups of missions.

The Solar-Terrestrial Probe missions will address fundamental science questions about the physics of space plasmas and the flow of mass and energy through the solar system. For example, Solar–B, a Japanese-led partnership mission, will be launched in 2006 to observe how magnetic fields on the Sun's surface interact with the Sun's outer atmosphere, which extends millions of miles into space. The STEREO mission, also to be launched in 2006, will determine the evolution of solar disturbances from the Sun's surface to Earth's



The blackness of space provides the backdrop for this scene of a Russian Soyuz TMA-4 spacecraft docked to the Station's Zarya functional cargo block nadir port in September 2004. While the Shuttle is grounded, the Russians have delivered crew and cargo to the Station. In the future, a combination of vehicles, including those provided by other international partners and commercial providers, will provide transportation to and from the Station.

orbit. And, the Magnetospheric Multiscale Mission, to be launched in 2011, will explore the fundamental physical processes responsible for the transfer of energy from the solar wind to Earth's magnetosphere and for the explosive release of energy during solar flares.

The Living with a Star missions will enhance scientists' knowledge of Earth–Sun system aspects that directly affect life and society. The Solar Dynamics Observatory, to be launched in 2008, will observe the solar interior and atmosphere continuously to determine the causes of solar variability. The Ionospheric/Thermospheric Mapper, to be launched in 2009, will help scientists understand, ideally to the point of prediction, the effects of geomagnetic storms on the ionosphere/thermosphere, a region in the atmosphere located approximately 53 to 620 miles above Earth's surface. And, the Radiation Belt Mapper, to be launched in 2012, will determine how space plasmas are accelerated to hazardous energies, thereby enabling scientists to predict changes to planetary radiation environments and protect space explorers.

Strategic Objective 16: Pursue opportunities for international participation to support U.S. space exploration goals.

Achieving the *Vision for Space Exploration* requires advanced systems and capabilities that will accelerate the development of many critical technologies, including power, computing, nanotechnology, biotechnology, communications, networking, automation controls and guidance, robotics, and materials. To meet these challenging technology requirements, NASA will invite active participation by the Agency's international and national partners. The resulting technologies will support and advance the space programs, economies, and security interests of the United States and all participating nations.

NASA values and seeks Agency partnerships with international, Federal, state, and local government agencies, industry, and academia that can help the Agency achieve its National Objectives. Humankind will benefit from the cooperation of nations that share expertise and leverage resources to develop space systems and other technologies that address universal scientific, security, and commercial interests.

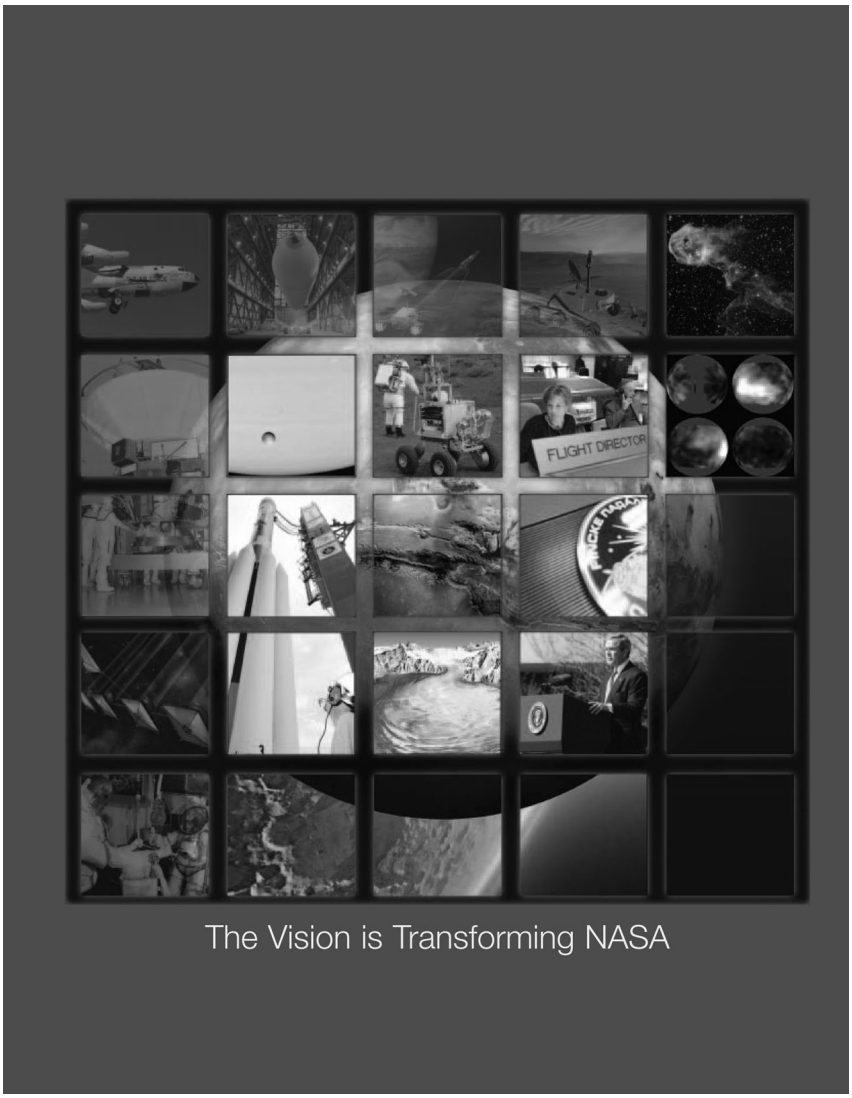
Strategic Objective 17: Pursue commercial opportunities for providing transportation and other services supporting International Space Station and exploration missions beyond Earth orbit. Separate to the maximum extent practical crew from cargo.

NASA will work with the Agency's partners to create a mixed fleet for International Space Station cargo re-supply. NASA also will seek commercial transport and other services both for the International Space Station and for missions beyond low Earth orbit. In particular, the Agency will seek existing or new commercial launch vehicles to transport cargo to the Station and, potentially, to the Moon and beyond. NASA also anticipates developing a significant number of new partnerships to help design, develop, and demonstrate the Crew Exploration Vehicle.

The Aldridge Commission recommended in its June 2004 report that private industry play a larger role in space operations, particularly in accessing low Earth orbit. Consistent with this recommendation, in September 2004, NASA issued a Request for Information for commercial cargo re-supply and return service providers. The Request for Information solicited information on current and planned space transportation capabilities to identify potential qualified providers. As the next step in the cargo re-supply acquisition process, NASA soon will issue a Request for Proposal.

Strategic Objective 18: Use U.S. commercial space capabilities and services to fulfill NASA requirements to the maximum extent practical and continue to involve, or increase the involvement of, the U.S. private sector in design and development of space systems.

As missions move further into the solar system, NASA will rely more heavily on private sector space capabilities to support exploration activities both in and beyond Earth orbit. In addition to tapping creative thinking within NASA, the Agency also will develop ways to solicit and leverage the ideas and expertise of the Nation's universities and non-profit organizations. For example, this year NASA will implement the full Centennial Challenges program which will establish and present prizes for specific accomplishments that advance solar system exploration and other NASA goals. NASA will continue working with government, industry, and academic partners to identify and achieve common research objectives and mutual goals. And, NASA will couple its technology with private sector technology, where possible, by establishing joint agreements and collaborations to mature technologies and transfer them to the commercial sector where they can benefit the public.


FLIGHT DIRECTOR
The Vision is Transforming NASA

NASA controllers monitor Station activities in the Station Flight Control Room at Johnson Space Center's Mission Control Center in October 2004.

The Vision is Transforming NASA

Implementing the *Vision for Space Exploration* requires a lead agency that can manage interdependencies and linkages between organizational units, focus and prioritize diverse activities, and integrate space science robotics programs with future human missions to the Moon, Mars, and beyond. NASA rapidly is becoming that kind of organization through a variety of transformation initiatives. Transformation is a long-term, continual process. Therefore, NASA has established three "optimal states," targets to guide the Agency on this journey.

- **Technical Excellence:** NASA safely and consistently meets mission objectives through relentless technical rigor and sound program and project management practices. The Agency also plans strategically, manages resources effectively, and collaborates to ensure that the right people have the right resources at the right times to execute the mission.
- **Organizational Excellence:** NASA balances rigor with flexibility and innovation in its organizational and business practices to ensure mission success and alignment with Agency core values. It also engages the American people to understand the relevance and value of its work to their general welfare.
- **People Excellence:** NASA employs a high-performing workforce and a cadre of exceptional leaders that are committed to NASA's vision and mission, consistently live Agency core values, and remain adaptable to an ever-changing environment. NASA also fosters an inclusive culture in which all members of the NASA family communicate openly, feel valued, and are empowered to ensure mission success.

Transforming NASA's Organization Structure

NASA's organizational transformation is off to a strong start. As of August 2004, NASA has four Mission Directorates—Exploration Systems, Space Operations, Science, and Aeronautics Research—and eight Mission Support Offices, including the Office of Education and the Office of Safety and Mission Assurance. The Agency's transformed structure includes a Strategic Planning Council and a supporting Office of Advanced Planning and Integration to enable better long-range planning, an Operations Council to integrate NASA's tactical and operational decisions, and a number of new or reconstituted committees that support NASA's focus and direction. Responding to a key Aldridge Commission report recommendation, NASA also is reviewing possible alternate organization models for the Agency's Centers.

Advanced Planning and the Road to the Agency's Strategic Architecture

NASA is focused on achieving the *Vision for Space Exploration*, and the organization's transformation includes new initiatives to improve communication among the Mission Directorates for effective project integration. One such key initiative is "roadmapping," developing specific courses of direction to guide the Agency's achievement of the *Vision for Space Exploration*. NASA is developing both strategic roadmaps and capability roadmaps for release in late 2005.

The strategic roadmaps will ensure that NASA's organization remains aligned and integrated as the Agency pursues the *Vision for Space Exploration* and the five National Objectives. Capability roadmaps will guide development of identified enabling technologies critical to attaining NASA's Strategic Objectives. They will include initial technology assessments, plans to develop and integrate mature technologies into the exploration architecture, and a strategy to transition appropriate technologies to the private sector.

Thirteen teams of nationally recognized scientists, engineers, educators, visionaries, and managers, working with NASA personnel and other government agencies, are developing the Agency's strategic roadmaps. In concert with this activity, 15 teams of subject matter experts are crafting supporting capability roadmaps. Together, the strategic and capability roadmaps will be integrated into NASA's Strategic Architecture, a NASA-wide framework for prioritizing and implementing program initiatives that will encompass the technical aspects of NASA's mission, as well as the workforce, institutional, facilities, and policy implications. This architecture will serve as a system of checks and balances for informed decision-making while providing a healthy, dynamic tension between long-term strategic and near-term tactical considerations. (For more information, visit *www.nasa.gov/about/strategic_roadmaps.html*.)

NASA's staff are critical to the overall success of the orgination and its goals. The Agency values professionalism, diversity, and personal growth among its staff and fosters teamwork, fairness, and respect.

Moving Toward One NASA

The concept of One NASA means that the Agency will operate as a single team and apply its unique capabilities to the pursuit of NASA's shared mission and the *Vision for Space Exploration*. The One NASA initiative enables better decision-making, enhanced collaboration, better leveraging of resources, decreased overlap and redundancies, and greater standardization to achieve efficiencies. It will move NASA toward the Agency's three optimal states by contributing to excellence in all areas, and it will promote sustainability by embedding these improvements permanently in NASA's culture. Through the One NASA initiative, NASA will accomplish together what no single organizational element could achieve alone.

Implementing the President's Management Agenda

In 2004, Office of Personnel Management Director Kay Coles James and Office of Management and Budget Deputy Director Clay Johnson, III, honored NASA as the first Federal agency to achieve the highest standards of excellence ("Green") in two of the original five government-wide President's Management Agenda (PMA) initiatives: (1) Strategic Management of Human Capital, and (2) Budget and Performance Integration. NASA also achieved "Green" in the PMA initiative of E-government. NASA's goal is to achieve "Green" ratings in all PMA initiatives within three to four years.

Assessing NASA's Core Competencies

In 2005, NASA's senior leaders are developing a set of Agency core competencies based on early assessments of the challenges ahead—key knowledge, skills, and capabilities that must reside within NASA if the Agency is to achieve its objectives. They will assign specific competencies to each NASA Center with as little overlap as possible. These competencies will be reviewed and adjusted periodically, with the first review occurring in late 2005 when the strategic and capability roadmaps are complete.

Embedding a Safety Culture

The *Columbia* Accident Investigation Board report cited two causes of the *Columbia* accident, one "physical" (the sequence of events on Shuttle Mission STS-107 that destroyed the orbiter), and the other "organizational" (the failures within NASA that allowed those events to occur). NASA is committed to creating a "safety culture" that addresses all of the Board's concerns.

Safety is NASA's first priority and a core Agency value. The plan for culture change starts with instilling safety-first behaviors throughout the organization beginning with the Agency's current senior leaders. This approach will establish a foundation for sustaining the safety culture even as leadership changes. Continuing culture-change initiatives include team effectiveness training at all levels of NASA, updating NASA-sponsored leadership and management development programs, and measuring organizational change through survey instruments.

In a ceremony held in April 2004, Office of Personnel Management Director Kay Coles James presented NASA Administrator Sean O'Keefe with a Kermit the Frog doll (left) in recognition of NASA achieving a "Green" rating for its progress in the PMA area of Human Capital. In return, O'Keefe presented James with a plaque of appreciation from NASA. Credit: R. Bouchard.

Ensuring Freedom to Manage

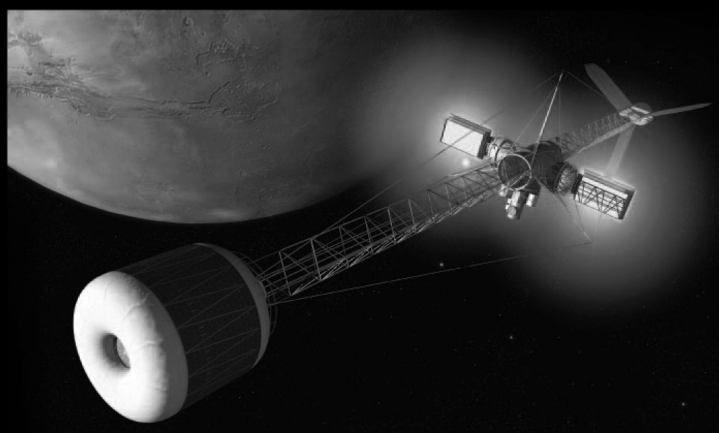
In 2002, NASA created the Freedom to Manage Task Force to identify internal and external impediments to effective management and recommend changes that would eliminate or minimize them. The Task Force considered externally imposed legislation and regulations and internally imposed policies and practices that limit managers' abilities to act responsibly. The Task Force also considered existing and non-existing authorities that, if put in place, would enable better management. The Task Force currently is moving a number of proposals toward enactment to ensure that the remaining impediments to management excellence receive the Agency's full attention.

Legislative Achievements in 2004

Numerous legislative proposals ultimately emerged from the Freedom to Manage Task Force last year, including passage of the NASA Workforce Flexibility Act of 2004. This Act gives the Agency exciting new tools and flexibilities with which to attract and retain a world-class workforce.

Continuing the Journey

NASA's future, and the future of America's space program, is as bright as the sun itself. For 46 years, NASA and its predecessor Agency have not wavered in their commitment to reach for and beyond the planets and the stars to better life on Earth for all humankind. NASA has the spirit, commitment, and energy to achieve the *Vision for Space Exploration*. The Agency will continue the journey to the future, as pledged to comrades lost and as promised to the explorers of tomorrow.



"This cause of exploration and discovery is not an option we choose;

It is a desire written in the human heart."

President George W. Bush
February 4, 2003

For more information or additional copies, please send an email to public-inquiries@hq.nasa.gov.

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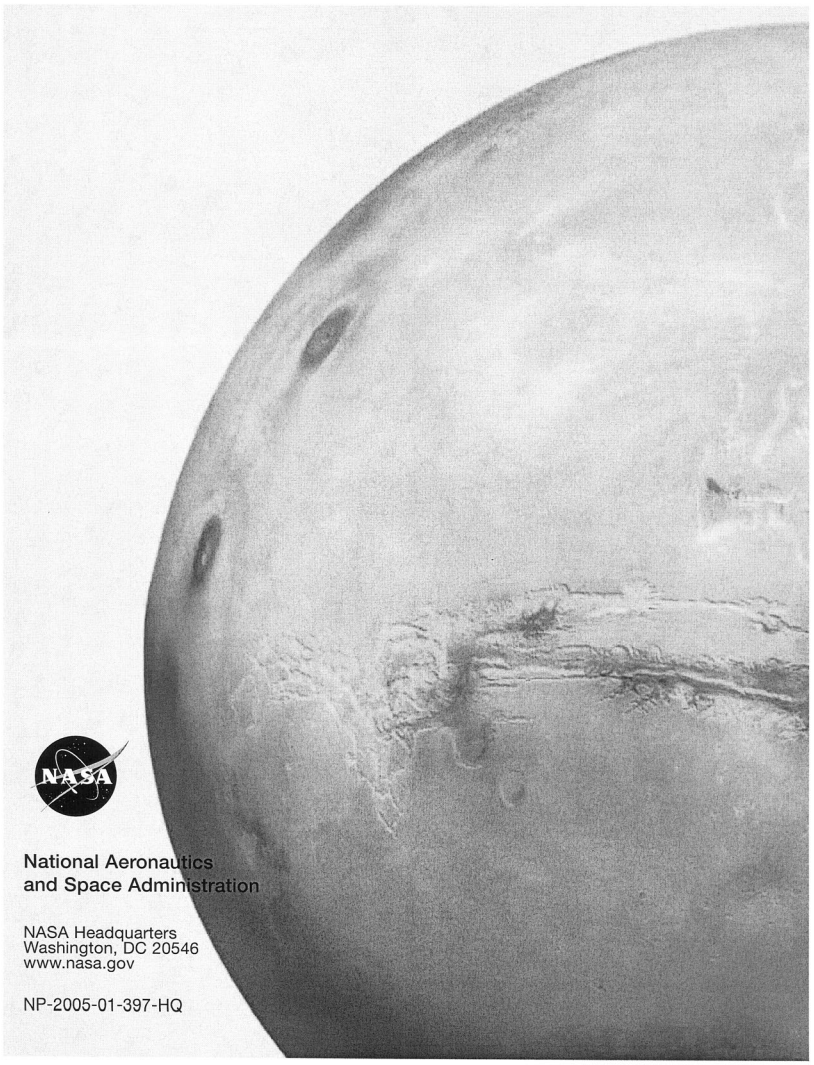
Above: A spacecraft, equipped with a centrifuge and nuclear–electric propulsion, travels to Mars in this artist's concept of future human space exploration. Credit: John Frassanito and Associates.



National Aeronautics
and Space Administration

NASA Headquarters
Washington, DC 20546
www.nasa.gov

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