DEPARTMENTS OF VETERANS AFFAIRS AND HOUSING AND URBAN DEVELOPMENT AND INDEPENDENT AGENCIES APPROPRIATIONS FOR FISCAL YEAR 2004

THURSDAY, MAY 1, 2003

U.S. SENATE,
SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS,
Washington, DC.

The subcommittee met at 10:03 a.m., in room SD–124, Dirksen Senate Office Building, Hon. Christopher S. Bond (chairman) presiding.

Present: Senators Bond, Stevens, Shelby, Craig, DeWine, Hutchison, and Mikulski.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF SEAN O'KEEFE, ADMINISTRATOR

OPENING STATEMENT OF SENATOR CHRISTOPHER S. BOND

Senator BOND. Welcome. The Senate VA–HUD Appropriations Subcommittee will come to order. Today we welcome NASA Administrator Sean O'Keefe and our other guests from NASA joining us today to testify on the President's fiscal year 2004 budget request for the National Aeronautics and Space Administration, NASA.

At the beginning of the year, I expected the NASA budget hearing to be a hearing of hope and optimism, of a renewed commitment to the International Space Station, as well as a continued emphasis on the importance of space and earth sciences. In some ways, I have not been disappointed. Mr. Administrator, since you took the helm of NASA, I have been impressed consistently with your efforts and commitment to ensuring the fiscal integrity of NASA's programs and activities while also refocusing the priorities on the International Space Station to ensure the station can meet its goal of its primary application as a working on-orbit science lab.

Unfortunately, with the tragic loss of the Columbia orbiter on February 1, NASA is again at a crossroads where the Nation's manned space flight program must be re-examined so that we understand fully the risk of life that is part of every mission. We also must acknowledge the bravery and heroism of every astronaut in the space shuttle program since manned space fight is inherently risky and will remain inherently risky for the foreseeable future.

I have been very much impressed with the Columbia Accident Investigation Board (CAIB) with Admiral Gehman at its helm. Be-

cause of the Board's fine work, I believe that we are beginning to gain the needed insight that will allow us to move past the Columbia tragedy and take the necessary steps to minimize the risk of a recurrent tragedy. It's only been 3 months since the Columbia tragedy and I applaud the Board for its substantial progress made already on the very complex and serious issues that underlie this disaster.

Without regard to the Columbia tragedy, NASA is requesting some $15.5 billion for fiscal year 2004, an increase of some $130 million over the 2003 funding level. The proposed 2004 budget for NASA was submitted prior to the Columbia tragedy and the ripple effect of this tragedy inevitably will impact the future funding of manned space programs as well as other missions in the space and earth sciences programs. For example, we provided a down payment of $50 million for NASA to respond to the Columbia tragedy and we expect these costs to rise. We also have a very tight allocation this year for fiscal year 2004, which regrettably could result in some significant reductions to a number of VA–HUD funded programs, including NASA programs, especially new starts. Unless we can get some relief, we are in for a very difficult time. However, I assure you that we will continue to explore avenues of getting some relief.

The future of the space shuttle is a key issue for NASA as well as this subcommittee. I support the shuttle program and manned space flight, but NASA and the Columbia Accident Investigation Board will need to identify the key safety issues that must be addressed to support continued manned space flight. In particular, what are the key causes of the Columbia tragedy? What's the useful life of the remaining orbiters? And what alternative or successor programs to the shuttle program are under review by NASA? And of course, what's the timeline and as we must address here, the estimated cost to meet all these concerns?

In addition, what's the impact of the Columbia tragedy on the International Space Station? I'm gratified that our partners in the international community have responded to the immediate needs of the International Space Station since the Columbia tragedy. This commitment by our international partners was most evident this past Monday when a Russian Progress delivered a new crew of two to the International Space Station with the intent of relieving the current crew of three who have been on station since November 25 of last year. This international cooperation bodes well for the future of the station and for our relationship with our partners to the International Space Station. Nevertheless, the subcommittee needs to understand the future expectations and potential cost issues facing the Space Station under this international partnership.

Finally, what's the impact of the shuttle program on other missions, including those which are part of the earth and space science program? What missions have been delayed and what additional costs can be expected will be incurred?

We have a number of questions on these issues and other concerns that I will either raise today or issue as questions for the record.

We are supposed to have a vote beginning at 10:15, which is going to cause us an interruption. Hopefully we will see how far

we can get and then we will recess the hearing, and whoever gets back here first will restart the hearing.

But now I turn to Senator Mikulski for her comments.

STATEMENT OF SENATOR BARBARA A. MIKULSKI

Senator MIKULSKI. Thank you very much, Mr. Chairman and welcome back. We're glad to see you on your feet again. Senator Bond had hip replacement surgery.

I think we're all clear that on February 1 our Nation suffered this tragic loss when the Space Shuttle Columbia exploded and seven astronauts lost their lives, and Israel also shared in our grief. We all agree that the best way to honor those astronauts is to get back in flight again.

But Senator Hutchison, before I talk about Columbia, I also would like to thank and acknowledge the wonderful work that the people of Texas did, working so faithfully, assiduously, and swiftly to recover the debris that is such an important part of the investigation. So for all those people in Texas and Louisiana, and the people coming forth with their video film, I think it has been a heroic and extraordinary effort, and a special salute to the people of Texas. It was a hard job but again, Texas, the Lone Star State is going to help us get back to the stars.

But when we look at where we are now, I think we're all in agreement that there needs to be a thorough and rigorous and candid investigation of what went wrong. The Columbia Accident Investigation Board is conducting their analysis and they report to the Congress and the American people, and from what we can see, it has been with candor.

But what I'm concerned about is as we get that report, will we have a direction and will we have the resources to proceed? My No. 1 priority, both as when I chaired this subcommittee and then as the ranking member, has been shuttle safety. It has been a shared bipartisan commitment that we would have shuttle safety, and this is what we need to be sure that we have focused on, that safety must come first no matter who is the chair and who is the ranking member.

For the last 2 years we've included report language stating that the safety of the shuttle and its astronauts must be a priority and we, I think, included funds to do this. And so, my questions today will focus on shuttle safety.

Also, though, there are the long-range issues at NASA that must be addressed. The future of the shuttle, whether the shuttle is whither thou goest, will it be able to go. It also points out an aging workforce and an aging infrastructure, and I am deeply concerned about these challenges.

And then of course, the work that we continue to need to do in the area of space science and aeronautics that is so important to us. The President's budget is $15.5 billion. This is just a little above the 2003 level. It is a status quo budget. So I'm not sure, where is the money to make sure that the shuttle can fly again, where are we going to go in space science, and also, how will we pursue some very interesting new initiatives?

For 2004, the budget proposes close to $4 billion for the shuttle. That's one-third of NASA's entire budget. This includes $281 mil-

lion to upgrade the shuttle and its infrastructure. We have to see what this means and we have to know what your plans are.

We have a big question mark about the Space Station budget. What's going to be the impact of the Columbia on the station, what are our international partners doing, and the whole issue of the astronauts currently there. Is the Soyuz or Progress reliable enough to get us through this difficult phase?

There are of course the science issues. Where are we on the Hubble, how would we be able to service the Hubble, what will be able to service the Hubble? The Hubble is very special to those of us in Maryland because so much of the analysis is done over on the Johns Hopkins campus, and Goddard is its catcher's mitt. Hubble needs to be addressed, what we do about that, and where are we in the next generation.

Then of course there is this issue of an aging workforce and aging systems. I understand 20 percent of NASA's scientists and engineers are eligible to retire within 5 years. The Apollo generation is retiring and again, most of the NASA centers are 40 years old. What are we doing to get ready for the future, what are we going to do about those issues?

Those are a quick thumbnail of what we want to talk about, the broad policy issues, and then focusing on the appropriations necessary to do that. And Mr. Chairman, I will pursue other amplified remarks as we go to the questions.

Senator BOND. Thank you very much, Senator Mikulski. I share, as well, in your congratulations and thanks to the people of Texas, New Mexico, Louisiana and others. Your comments about shuttle safety are right on. We have pursued that. And we have been discussing the problem of the aging personnel at NASA, and this is a huge bow wave question coming down the pike that we need to review.

I'm going to turn now to the others for their introductory comments. If the buzzer rings for the vote, I will turn the gavel over to Senator Mikulski or to anybody else who will stay here so we can continue with the opening statements. It takes me a long time to get there and to get back, so I'm going to start whenever it does ring.

But with that, I believe the first one to join us was Senator Hutchison.

STATEMENT OF SENATOR KAY BAILEY HUTCHISON

Senator HUTCHISON. Thank you, Mr. Chairman, and I do appreciate the comments of both the Chairman and the Ranking Member regarding the people of Texas. I have been to the area since the Columbia tragedy and they just were so happy to be able to be helpful, not happy about the situation, but they felt such a part of finding the answer, and the people there felt that it was a very important mission they had, they took it that way and wanted to make the contribution that I do believe they have made.

I want to talk just for a minute about certainly the future of the shuttle, because I think it is just absolutely essential that we renew our commitment to the shuttle and to the manned shuttle, because NASA has done so much space exploration, they have done in the field of research and technology growth. It is one of the rea-

sons that the United States has maintained its superiority in economic growth in the world.

And all of the jobs that have been created from this, even the Columbia, have made huge contributions in scientific research because they were able to feed back every day, every hour, every minute the results of their tests. They actually did do some research that might one day lead to advances in the elimination of prostate cancer, and there were many other scientific experiments that we were able to retrieve even from the Columbia.

I think there is no substitute for having people involved in the research that we are conducting. So the idea of sending up unmanned shuttles, which can be effective in some ways and for some purposes, but not as a substitute for having people there to do the experiments and to correct things and to adjust.

Secondly, I do want to say in the budget request that I'm pleased to see the support for the base budget for the National Space Biomedical Research Institute for $30 million. I think this is one of the great success stories of our ongoing efforts with space exploration, and I think there is so much more that we can do in this area and we need to make sure that we have the capability to bring back the data that we have, and also have a place then to dissect and use the information. So, I am very pleased about that.

In fact, I have to say that I believe NASA is getting its budget priorities straight. I was one of the harshest questioners of you, Mr. O'Keefe, because I was worried very much that NASA was drifting from their core experimental and technological advance mission. And when you came on board, you wanted to take a look and see what the priorities should be, you had your scientific mission and you said yes, in fact we should continue with scientific research, and you are taking that ball now and I think running with it as this budget shows. So I want to say, I am pleased with that.

The other thing I just want to mention regarding manned spacecraft and shuttles is that I believe the investigation has been open and candid, which is very important, and certainly something that we learned was not the case for the Challenger, and it took a longer time.

But I do hope that as things are beginning to come out, as this is beginning to come to closure, that you are going to come back to us with a system of communications from the bottom to the top, so that we will know that even maybe some irrelevant observations will be brought forward, because it's worth it to separate the wheat from the chaff in this instance. I don't know and I assume you don't know if something could have been done after the takeoff that would have made a difference, but there clearly were concerns at the bottom, and I think that having a communication system to assess those concerns and determine if in fact there is something that could be done is essential for manned spacecraft.

PREPARED STATEMENT

So, I will say with that, that I do think we're getting on track, you have taken the time and I just, I have never seen a sadder face on any person than I saw on you following the Columbia accident, and I know you have taken to heart all of the issues that have been brought forward, and I think you are doing the right thing by keep-

ing it open. And I want you to continue to do the right thing by keeping our priorities, keeping our focus, and making sure we have communications systems in place to implement that vision. Thank you.

[The statement follows:]

PREPARED STATEMENT OF SENATOR KAY BAILEY HUTCHISON

Mr. Chairman, I am pleased to return to the VA–HUD/NASA Subcommittee, and I am more encouraged by this year's NASA budget than I have been in years past.

I want to start by commending the thousands of people who have been involved in the recovery efforts for the Space Shuttle Columbia since the tragic accident on February 1, 2003. I appreciate NASA Administrator O'Keefe being here today to update us on the Columbia recovery and NASA's overall mission.

With recovery efforts headquartered in Lufkin, Texas, significant progress has been made as over 5,000 workers and dozens of aircraft have been searching for Columbia pieces every day. The main search areas in Texas span along the Columbia's flight path which is 10 miles wide and 240 miles long. Altogether over 80,000 pieces of debris have been found—this amount of debris represents 38 percent of the Space Shuttle Columbia.

The Space Shuttle Columbia was an important mission for scientific research, with more than 80 experiments aboard. With a satellite downlink between the Columbia and Johnson Space Center in Houston, scientists were able to retrieve a tremendous amount of data in real-time. On the Columbia, a large amount of the science was aimed at saving lives. With the astronauts working in 12-hour shifts so that experiments could continue around the clock, the crew was able to provide a large body of knowledge. One study involved the growth of prostate cancer tissue, which may potentially lead to advances in treatment.

Altogether the Columbia carried four tons of scientific gear, and many of the experiments were designed to keep scientific studies underway until the International Space Station is complete. We can be proud of the Columbia crew for their efforts, and their ultimate sacrifice, to save lives here on Earth.

On a related scientific research point, I want to say I am pleased to see support in the NASA Fiscal Year 2004 Budget request setting a base budget for the National Space Biomedical Research Institute (NSBRI) of $30 million. The NSBRI is one of the great success stories that has drawn many outstanding biomedical scientists into space life sciences research to solve problems and risks associated with long duration human space flight.

In my view, NASA is getting its budget priorities back on track. As we discover the cause of the Space Shuttle Columbia tragedy, we must next ensure that we continue to develop a vision for the future of human space flight.

Thank you.

Senator MIKULSKI [presiding]. Senator Shelby.

STATEMENT OF SENATOR RICHARD C. SHELBY

Senator SHELBY. Thank you. Mr. O'Keefe, I want to welcome you here. I have a number of questions for later on. We appreciate what you're doing, the leadership that you brought in difficult times with NASA. All of us who sit on this committee and have funded NASA for many years, most of us, if not all, believe that NASA is still vastly underfunded, considering the potential there, the missions and so forth, and I want to work with you and the administration to try to get more funding for vital programs that come under your jurisdiction at NASA.

I am just pleased that we have profited so much from the basic research and the technology that has been brought forth from your NASA's endeavors. So with that, I'm going to try to vote and I will be back later to get your questions. Thank you.

Mr. O'KEEFE. Thank you, sir.

Senator MIKULSKI. Thank you, Senator Shelby. Senator DeWine.

STATEMENT OF SENATOR MIKE DEWINE

Senator DEWINE. Mr. O'Keefe, thank you for joining us, and I just want to congratulate you for the excellent job that you have done as administrator and really the great job that you have done in light of this horrible tragedy that has hit NASA. I think everyone is very proud of the job that you have done and we appreciate that very much.

I want to join my colleague from Alabama and also say that I believe that NASA is underfunded and we're going to try to over time to work on that issue as well. I look forward to hearing your testimony and I appreciate you being here. Thank you, sir.

Mr. O'KEEFE. Thank you, sir.

Senator MIKULSKI. The committee will now stand in recess subject to the return of the chair, and at that time we will take the testimony of Sean O'Keefe, the Administrator.

Senator BOND [presiding]. All right, we will reconvene the hearing and now we are ready for the testimony of Administrator O'Keefe. Sean, please go ahead.

STATEMENT OF SEAN O'KEEFE

Mr. O'KEEFE. Thank you, Mr. Chairman. I appreciate the opportunity to be here. With your permission, I will summarize the statement and ask that the full statement be inserted in the record.

Senator BOND. Without objection.

FISCAL YEAR 2004 BUDGET REQUEST

Mr. O'KEEFE. This is an opportunity to appear before the committee to discuss the President's Fiscal Year 2004 Budget proposal for $15.5 billion for NASA. This is a $500 million increase over last year's proposal in the 2 or 3 months after the submission of this one, for 2003.

That request demonstrates the administration's continued confidence in NASA's ability to advance the Nation's science and technology agenda. It's also an opportunity, I must say from a personal standpoint, with the committee staff along, to appear here before the committee. You always treat me, Mr. Chairman and Senator Mikulski, as the equivalent of an amicus brief or friend of the court in that regard, and I thank you for that courtesy.

The budget, we believe, is responsive and funds our highest priorities. It's credible. It builds and reserves for technically challenging programs, fully accounts for program costs, and we hope and like to think that it's a compelling effort which enables new initiatives tied to our strategic objectives. It advances our mission goals through a stepping stone approach for exploration objectives, and provides transformation of technology and capabilities for all programs we have open.

The proposals embody a new strategic direction for NASA and how we plan to shift resources towards longer-term goals outlined by our mission, and it's summarized in the 2003 strategic plan which is on the website, and there are a couple remarkable features to it.

The first one is, it's short, it's readable, it's written in English, and it's on a website in time for submission of the President's budget proposal submitted in September, as it typically is in most Federal agencies and departments, so hopefully that would get some currency across the board.

Before describing some of the objectives, sir, I would appreciate during my opening statement to describe a brief update on the Shuttle Columbia recovery efforts.

COLUMBIA RECOVERY EFFORT UPDATE

The ground, air and water search for Columbia is complete. The base camps at Nacogdoches, Palestine, Corsicana and Hemphill are either closed or in the process in the next few days of closing. The main consolidation and operations point at Lufkin will close by the 9th of May, and all the effort has been timed not around a calendar, but based on completion of the recovery itself.

The charts that we've brought along here, which I got when I was out there a few weeks ago reviewing the current progress, each of those were an attempt to give you sort of a sample of it, because it goes on forever. But each of these grids that they approach here, they would designate in a green color once they have completed that, that is, the U.S. Forest Service, EPA and NASA, and other folks that are actually searching the area. At this point, they are all covered. They have covered every single acre of the 550,000 acres that stretch along that blue strip there from south of Dallas-Fort Worth to the Texas-Louisiana border across Toledo Bend, which represents about a 250-mile range, about 10 miles wide, and every acre of that, which accounts roughly to the equivalent size of the State of Rhode Island.

Senator BOND. Sean, let me interrupt. Is there any pattern where there was significant debris, is there some kind of submission you can give us to show where it was found and does the location have importance in the assessment of the causes?

Mr. O'KEEFE. It did indeed. As a matter of fact, the pattern is, you can see the blue line intensifying there in that area. If you saw it up close, it would just be an area south of Dallas-Forth Worth to the far left, and the Texas-Louisiana border is right there at the point where it's light green shifting to the kind of brownish. That blue line is the intensity, the primary areas where it was picked up. The wreckage field, again, is about 10 miles wide, but that's where it was intensely focused.

You're exactly right, there were certain parts and certain pieces which were picked in certain areas, that did after time start to unfold a pattern of exactly how this occurred. The left wing, which much has been written about, the wreckage is much further downstream and closer towards the Corsicana-Nacogdoches area which is on the left side of the debris field. The right wing, which stands to reason, stayed in place for a longer period of time and was among the last things to break up, as well as the crew compartment, et cetera, and these were closer towards the Hemphill area, which is right near the Louisiana border.

So from that, we piece together a much more comprehensive understanding of precisely how this happened, and the Columbia Accident Investigation Board is coming to a conclusion on hypotheses

and theories based on exactly that sequence, not only what you find but also where you find it and exactly what condition it's in as we move along.

During the course of this last 90 days, all these teams have collected 85,000 pounds of debris, and that represents about 40 percent of the Columbia's weight. Of more than 80,000 specific items that were picked up, approximately 76,000 have actually been tagged and identified. I was just down at Kennedy Space Center Monday evening, and they have identified the better part of them, and of the 76,000 they have actually arrayed out about 10 percent of it. That demonstrates exactly what the pattern of the wreckage will tell us occurred on that terrible morning.

Of that grouping, about a thousand pieces came from the left wing. They have now been able to piece that together and to reassemble significant portions of the left wing. It will be nice to examine the intensity of the heat, as well as the heat flow demonstrated on that particular event.

On the 29th, I met with the search teams in Lufkin, Texas. Again, we have essentially closed all of the four primary base camps, and NASA has formally acknowledged and appreciates very much the efforts that the folks in East Texas and West Louisiana have contributed in this particular effort. It is indescribable, the activities that all of the 120 agencies from the Federal, State and local activities have contributed, as well as that of the communities, which has been just overwhelming, inviting volunteers as well as Federal public servants into their homes during the course of this very, very arduous effort.

The initial prediction was that we might find and recover on the order of 10 percent, maybe. We have exceeded that by a factor of 4, and that is largely due to the extraordinary efforts on the part of an awful lot of folks who live in the east Texas area who have been just incredible partners and assistance in all this.

So Senator Mikulski, you are exactly right. I believe the folks in the Lone Star State have helped us return this particular case.

The independent Columbia Accident Investigation Board, as you mentioned, Mr. Chairman, under the leadership of Hal Gehman, has made significant progress in organizing the work and again, looking at not only the facts and evidence that came back from the mission control information, but also a lot of the OEX recorder that was recovered a few weeks back. To your question again, Mr. Chairman, that was located in the area very much towards the southeast portion of this stream, right near the Louisiana border.

It was found on the second pass over that same acreage. There has really been an incredible case of not only a lot of human effort of literally walking over every single acre, of examining the debris field itself, but also using that analysis to inform where other parts may be.

To your observation, Mr. Chairman, the OEX recorder was in a specific compartment that we found several different pieces of in a very specified grid near Hemphill. Having returned after covering it the first time and not having found the recorder, and having seen the analysis that indicated here were all the other parts we did find, a lot of our folks asked the U.S. Forest Service, the EPA and our people, to go back and look over that acreage one more

time, it covered about 5 acres, because if it was going to be found, it was going to be found in that one spot.

On that second pass, they found it. It was really using the technology and analysis of what we found, where we found it, how it was recovered, what condition it was in that really led us to a lot of the efforts that have gone on here. So it has been an enormous effort to inform the nature of the investigation, and this board has really valued that contribution.

We have kept the pledge, and I appreciate your comments, all the opening comments from members of the committee, that we have indeed handled this is an open manner. We are candid with the Accident Investigation Board even if that means that some of the earlier findings or theories prove to be opposite of that, that's fine. We're hoping that the findings and facts will speak for what occurred here and we continue to work with them to determine the nature of how this event occurred.

I concur with you, sir, that Admiral Gehman has been incredibly diligent in working through this effort, and they have been very forthcoming in all the public hearings and press conferences describing exactly the direction they are moving. They are narrowing in on a set of theories that will be released in the weeks ahead.

HUBBLE SPACE TELESCOPE ANNIVERSARY

I would also like to point out that the past week, on April 24 we celebrated the 13th anniversary of the launching of the Hubble Space Telescope. In honor of that anniversary we released the Hubble image that was passed around before you, which we have characterized as the perfect storm of turbulent gases shot. It has a more formal title, the Omega Nebula, but it was one that was just released this past week. The image captures a small region within a very specific area known as the Omega or Swan Nebula, located about 5,500 light years away from the constellation Sagittarius.

There is another one we're going to release next week, and as a preview of coming attractions, we have passed that around as well, which is the Helix Nebula. It is also just a stunning piece. It will be released early next week from the Hubble Institute as well.

FISCAL YEAR 2004 BUDGET REQUEST

The Fiscal Year 2004 Budget contains 9 specific initiatives, 5 initial goals that again, are built on a plan that I like to think is very short, easily readable and specific.

PROJECT PROMETHEUS

They include first and foremost, an effort to really address the power generation or power limitations and propulsion limitations that we currently wrestle with on every mission we are engaged with. We are looking for a new power generation and propulsion capability in the time ahead to accomplish not only speed, but on orbit kind of examination of any of the outer planetary missions we may engage in.

Project Prometheus is our effort to do that, an ambitious effort to develop and to build nuclear reactors for the purpose of pro-

viding propulsion and power generation capabilities. We tend to enlist the experience of better than 40 years of our friends in the naval reactors community to design reactors that are significantly smaller than that but generate about a factor of 100 greater power than we currently deal with today on every single space probe mission.

HUMAN RESEARCH INITIATIVE

The second major area I think is of particular focus as well, and it's also a limitation that we have dealt with for a long time and need to wrestle and understand better how to conquer. We developed a human research measure, the expanded biomedical research and technology development to enable long-duration missions on the International Space Station or any other vehicle as potential means of missions beyond low orbit.

Benefits that come from this are again, just this past June, less than a year ago we set the longest duration U.S. space flight record of 196 days, Dan Bursch and Carl Walz accomplished that task. That was about the time it takes to get from here to Mars, and that's it. That's the longest we've ever had anyone.

So the idea of experiencing that particular effort is a real challenge, because the physiological consequence of that is just downright profound. During the course of any stay on the International Space Station, every astronaut and cosmonaut receives the equivalent radiation of 8 chest x-rays a day.

During the course of the missions, as we see in the case of Expedition 4, that Dan Bursch and Carl Walz worked through, as well as those who returned, Ken Bowersox, Don Pettit and Nikolai Budarin, they are coming back this weekend after 5½ months up there. They will likely experience what we typically find of about a 30 percent muscle mass and about a 10 percent bone mass degeneration.

If we can figure out ways to arrest this in this human research initiative that we have budgeted for and specifically provided a very aggressive effort to understand, better arrest that degeneration as well as provide for the appropriate shielding from exposure, that will have applications not only for long duration space flight and the opportunities for future space exploration, but it has direct applications for all of us here on earth.

If we can determine how to arrest that, just the bone mass deterioration issue, that in turn may make you one of the few folks who will have to go through hip replacement in the future, Mr. Chairman, and hopefully accomplish that so that those who follow won't have to suffer the challenges that you're wrestling with right now.

Senator BOND. It might be simpler if they didn't play rugby, but go ahead.

Mr. O'KEEFE. We'll have to look at some life habit kind of changes as well, I guess, but it nonetheless is an opportunity to apply all kinds of different applications and approaches to these sets of challenges here on Earth.

OPTICAL COMMUNICATIONS INITIATIVES

The third area that we emphasize, the optical communications initiative is an investment in revolutionary laser communications

technology that we intend to demonstrate on a mission to Mars later this decade, by transmitting large volumes of information that right now take us a ferocious amount of time.

The effort that currently is underway takes us the better of about 2 years, these last 2, to map about 20 percent roughly of the planet Mars. With this particular initiative, you can do that in about 4 months for the entire planet. That's the difference in speed of communications as well as capabilities.

BEYOND EINSTEIN INITIATIVE

The fourth area that you will see emphasized here is a beyond Einstein effort, to look at a couple of specific observation observatories: A deep-space gravity wave detector, LISA; as well as Constellation-X, a mission probing to look at the edge of black holes, both of which are to look at those theories and specifically capitalize on those efforts and understand what's involved.

CLIMATE CHANGE RESEARCH INITIATIVE

The fifth is the climate change research initiative. The President has directed all of us within 11 different agencies to engage in and be involved with, to collect the information, to accelerate the research, and to key scientific uncertainties that inform the kind of changes that are occurring within our own climate here and the environment that is affected by the way we conduct our habits as human beings, and to collect that data and then inform what the appropriate protocols would be to alter that set of habits.

AVIATION SECURITY INITIATIVE

The sixth is the aviation security initiative to expand research to develop technologies that will in turn, we believe, reduce vulnerabilities of aviation to terrorist and criminal attacks. The proposition that anyone could use a commercial airliner for the purpose of terrorizing us again ought to be eliminated by simply the use of technology, which would eliminate their capability to take over aircraft in those circumstances.

NATIONAL AIRSPACE SYSTEM TRANSFORMATION AUGMENTATION

Seventh is the national aerospace system transformation augmentation, which translates as trying to do better airspace management. It's one thing to encounter as we do nowadays, since September 11, a very real change in the way we conduct our activities for commercial transportation, and the amount of time we wait to go through security efforts. But it's another thing to have to have aircraft stacked up waiting for departure and landing opportunities. There's a way, I think, of improving that efficiency through airspace management.

QUIET AIRCRAFT TECHNOLOGY ACCELERATION

Quiet aircraft technology certainly is a persistent issue of trying to deal with urban noise pollution and this is one of the things we specifically could improve.

EDUCATION INITIATIVE

Finally and maybe most important in terms of our effort to inspire the next generation of explorers as part of our mission objective, we have pursued the Educator Astronaut Program which was announced in late January and since that time, there have been over 1,600 applications from educators around the country who seek to be astronauts as part of that effort. Better than 8,600 people were nominated during the course of that time. The applications do close tomorrow, and in the course of that effort of that 1,600 applications, we will review in order to select 3 to 6.

So the interest in the wide range of activities in the astronaut corps certainly is unabated as a consequence of the tragedy of February 1. Indeed, it may have even heightened since that time.

Within the next few weeks, NASA will make 50 awards for NASA Explorer Schools, involving unique partnerships within NASA and the school teams at the middle school grade levels across the country to join educators, administrators, students and families, to sustain involvement with NASA research discoveries and missions.

The budget also builds on the work of this committee and the Congress in the February omnibus appropriations bill containing many needed elements to help address key power, propulsion, transportation and human capability restraints.

The budget specifically funds the International Space Station as you said, Mr. Chairman, in your opening statement. There is no difference to speak of between three different estimates of what it will cost, we know what that's going to be, and we can now develop a plan which will complete the International Space Station as soon as we can return to safe flight. It accommodates our international partner elements, maintains progress on research priorities, as Senator Hutchison alluded to in her opening statement, and continues to build out the International Space Station in order to then organize all research through a nongovernmental organization like the Hubble Institute to specifically organize up with the International Space Station the research we will do in the years ahead.

INTEGRATED SPACE TRANSPORTATION PLAN

The Integrated Space Transportation Plan, which again, we appreciate the endorsement and support of this committee as you did in the Fiscal Year 2003 Budget, to specifically make investments in not only the service operational life efforts for upgrades and modernization, but the Orbital Space Plane, to get that started as a crew transfer vehicle between here and the International Space Station. And the next generation launch technology efforts in propulsion, structures and operations, to provide that future replacement for shuttle in time.

BUDGET RESTRUCTURING

Along with the strategic plan that I mentioned, we're also submitting an integrated budget performance document and performance accountability report, all earlier than is typically required by law, in order to give some meaning to the context of the budget that we had planned, developed and released on February 3.

The documents reflect agency improvement in specific areas dealing with budget restructuring in accordance with the committee's instruction in that regard; full-cost accounting and management, in order to reflect the total cost of what it takes to do something as opposed to having it spread throughout the budget and trying to find what the pieces or parts are. You can now look at the Fiscal Year 2004 Budget and see what the total expense is in order to actually carry out some task.

INTEGRATED BUDGET PERFORMANCE

The third area is an integrated budget performance effort to try to demonstrate the linkages between performance and what the budget request is that we have pending before you, to inform the Congress of promised cost, of the schedule, of technical parameters to improve projects, merging the budget with performance plans specifically.

INTEGRATED FINANCIAL MANAGEMENT SYSTEM

Then the integrated financial management system, which again, the endorsement of this committee has been invaluable to proceed with. It is our third attempt doing this and I want to advise you now, this one is successful, it's being implemented now. The last three centers, Goddard, Dryden Flight Center out in California, and the final one is—I'm sorry, the third one escapes my memory for the moment, but the other three, they will be implemented by June. The rest are already on this system and that core financial system is operating today. So by July, there will be one financial system at the National Aeronautics and Space Administration.

AUDITED FINANCIAL STATEMENTS

Finally, on this vein, we have completed and have extended dialogue last year, if you recall before this committee, on the audited financial statements. We have received a clean opinion this year, unqualified, our books are in order. We have a lot of work to do to maintain that, and a lot of what's been involved in implementing the Integrated Financial Management Program into that one core financial system is going to help us achieve that year after year. I don't anticipate a repeat of last year's disqualified opinion.

HUMAN RESOURCE CHALLENGES

And in conclusion, let me just offer a thought that Senator Mikulski introduced in her opening statement as it pertains to the human resource challenges we have. Indeed, that is a matter that we are really deeply concerned about, but can get ahead of now if we do some things today and in the future, very near future, in order to look to recruit, retain, as well as professional development of those who are within the Agency today.

PREPARED STATEMENT

The President submitted legislation back in June of last year that would provide those specific tools. There are two pieces of legislation introduced, with Senator Voinovich here in the Senate, as well as over in the House, have introduced legislation that specifi-

cally moves those initiatives forward, and we seek enactment of those as soon as is possible in order to develop those tools, use them, and get ahead of this particular bow wave of retirements that we see looming here in the very, very near future. So it's an opportunity today to deal with that, as opposed to dealing with it in a crisis condition just a couple years from now.

Mr. Chairman, again, thank you very much for your indulgence. I appreciate the opportunity to be here.

[The statement follows:]

PREPARED STATEMENT OF SEAN O'KEEFE

Mr. Chairman and Members of the Subcommittee, I appreciate the opportunity to appear before the Subcommittee today to discuss the President's fiscal year 2004 budget proposal of $15.47 billion for NASA. The President's request demonstrates the Administration's continued confidence in NASA's ability to advance the Nation's science and technology agenda.

We come together to discuss NASA's space research and exploration agenda, and our efforts to advance aviation safety and efficiency in this Centennial of Flight year, still mourning the tragic loss of the courageous crew of the Space Shuttle Columbia. Before I discuss the details of the budget, I would like to provide the Subcommittee an update about the on-going investigation.

Since the tragic loss of Columbia, our work continues to honor the solemn pledge we've made to the families of the astronauts and to the American people that we will determine what caused the loss of Columbia and its crew, correct what problems we find, and safely continue with the important work in space that motivated the Columbia astronauts and inspires millions throughout the world. A grateful Nation has laid to rest with full honors, six American heroes: Rick Husband, William McCool, Mike Anderson, Dave Brown, Kalpana Chawla and Laurel Clark. The people of the state of Israel also paid their final respects to Israel's first astronaut, Ilan Ramon. At all these ceremonies, NASA was represented by myself and/or other appropriate Agency officials. We continue to be sensitive to, and supportive of, the needs of the astronauts' families and will be at their side as long as our support is desired by them.

I am pleased to note that the Columbia Orbiter Memorial Act was part of the "Emergency Wartime Supplemental Appropriations Act, 2003," signed by the President on April 16, 2003. I want to personally thank Senator Stevens for introducing the legislation on March 18, and Senators Bond and Mikulski for co-sponsoring this legislation that honors the fallen heroes of STS 107. NASA is grateful for your leadership and support. The legislation authorizes construction of a memorial at Arlington National Cemetery near the memorial to the crew of the Space Shuttle Challenger. The legislation also authorizes NASA to collect gifts and donations, over the next five years, for the Columbia Memorial. It also permits NASA to erect other appropriate memorials or monuments with private donations. The law allows NASA to transfer collected money or property for the fund to the Secretary of the Army to defray expenses. Memorial fund procedures will be established and announced in the near future.

Columbia Recovery operations, which began as soon as it became clear that Columbia was lost, have continued on the ground, in places along the Shuttle's reentry path, stretching from San Francisco, California to Lafayette, Louisiana. We continue to send everything we find to the Kennedy Space Center in Florida for assembly and analysis as part of the Columbia Accident Investigation Board's comprehensive accident investigation. In addition, we are appreciative of the fact that the fiscal year 2003 Omnibus Appropriations Act included $50 million in funding to help pay for the costs of the recovery operation and accident investigation by the Columbia Accident Investigation Board. We have established a new accounting code in the NASA financial system to capture the agency's costs associated with Columbia recovery and investigation, titled Columbia Recovery and Investigations. We are monitoring very closely the costs associated with this effort and we will ensure that the Congress is kept apprised of this effort. The Federal Emergency Management Agency is shouldering the resources required by other public agencies at the Federal, state, and local levels.

The ground, air, and water search for Columbia debris is essentially complete. This search has been extremely helpful to the investigation. NASA is deeply grateful for the support we have received during recovery operations from the more than 6,000 men and women from the Department of Homeland Security, Federal Emer-

gency Management Agency, Environmental Protection Agency, Federal Bureau of Investigation, Department of Defense, Department of Transportation, U.S. Forest Service, U.S. Park Service, Texas and Louisiana National Guard, state and local authorities, and private citizen volunteers who have helped us locate, document, and collect debris.

I am saddened to note that one of the helicopters searching for debris from the Space Shuttle Columbia crashed in the Angelina National Forest in east Texas on March 27. The pilot and a Forest Service Ranger were killed in the crash, and three other crewmembers were injured. Our thoughts and prayers go out to the families of the helicopter crew members killed in the accident. We deeply empathize with their loss at such a trying time. We also pray for the speedy recovery of the injured crew members.

I returned to Palestine, Lufkin and Hemphill, Texas on April 16, where I met with many of the volunteers in the surrounding area who are involved in the Columbia recovery effort. I saw firsthand their dedication and I can report to the Subcommittee that morale is high and the continued commitment is strong to recover as much of Columbia as we can. The NASA family is grateful for their assistance. On April 29, I met again with the search teams as NASA formally celebrated and acknowledged all of their outstanding contributions since February 1. As of that time, all ground, air and water search operations were on track for completion in early May and the search base camps will be closed by May 10.

At the peak of the Columbia debris recovery efforts nearly 6,000 personnel working in Texas and Louisiana were involved in Shuttle recovery operations. The field operations involve three main components—ground, air, and water search efforts—to search an area of 250 miles long by 10 miles wide. In each of these operations the searchers, NASA engineers, and EPA technicians are working side-by-side.

The ground search depends on fire crews from 42 States, operating out of four base camps, supported by two local logistics centers. So far, they have searched over 525,000 acres. The air search depended on 35 helicopters operating out of two air bases, each staffed by forest service pilots and NASA engineers. They have searched nearly 2 million acres.

The search of Lake Nacogdoches and the Toledo Bend Reservoir depended on the collaborative efforts of 66 United States Navy and state Police divers and a team of side-scan and multi-beam sonar analysts. In total, 3,100 targets were cleared in Toledo Bend, 365 in Lake Nacogdoches and many targets in a dozen small ponds throughout East Texas. The total water area searched was nearly 18 square nautical miles. No Columbia debris was recovered.

The meticulous search for evidence is resulting in important clues that will assist the work of the Columbia Accident Investigation Board. As of April 28, nearly 85,000 pounds of debris have been recovered, representing approximately 38 percent of Columbia's dry weight. Of the more than 80,000 specific items recovered from the accident, more than nearly 76,000 have been identified, with 702 of these coming from the left wing of the Orbiter.

Through the assistance of research institutions and helpful citizens, we have received video tapes that document Columbia's final moments as it streaked across the southwestern United States. The videos pick up Columbia as it approached the coast of California and cover most of its flight path toward the skies over East Texas, with the exception of some gaps in video coverage of Columbia's flight path over sparsely populated areas of eastern New Mexico and northwestern Texas. The video imagery is being used along with radar and telemetry data to help engineers determine the potential location of debris that was shed from Columbia.

The Independent Columbia Accident Investigation Board under Admiral Gehman has made significant progress in organizing its work to determine the cause of the accident. NASA has kept its pledge to fully cooperate with the work of the Board, and has taken the necessary steps to ensure the Board's complete independence.

IMPLICATIONS OF SUSPENSION OF SHUTTLE FLIGHTS

The ISS Expedition 6 crew—Commander Ken Bowersox, Science Officer Donald Pettit and Cosmonaut Flight Engineer Nikolai Budarin—have been performing science while performing routine ISS maintenance on orbit. The Expedition 7 crew—Edward Lu and Yuri Malenchenko—arrived at the ISS early Monday, April 28, and received turnover briefings from the Expedition 6 crew who returned to Earth on Saturday, May 3 in Soyuz 5S. There are no threats to the ISS or its crew in the near-term, and we are working options to be able to sustain both over the long-term. All remaining U.S. manufactured ISS hardware for the Core Complete configuration has been delivered to KSC and element ground processing is on schedule. Delivery of Node 2, built for NASA by the European Space Agency, is on schedule for ship-

ment to the Kennedy Space Center later this month. Ground processing will continue until ready for Shuttle integration. Only one ISS mission, STS–118, in the critical path to U.S. Core Complete was manifested on Columbia. The primary mission objective of STS–118 is the transfer and installation of the S5 Integrated Truss assembly to the S4 Truss. While the manifest for the remaining three Orbiters will need to be adjusted to accommodate this flight, all other previously scheduled ISS assembly missions will be flown in their original order. A revised U.S. Core Complete assembly schedule will be confirmed when the Shuttle is ready to return to flight status.

In the absence of Space Shuttle support, NASA is addressing contingency requirements for the ISS for the near- and long-term. As I said earlier, there is no immediate danger to the Expedition 6 or 7 crew. In order to keep the crew safe, however, we must ensure that they have sufficient consumables, that the ISS can support the crew, and that there is a method for crew return available. Working closely with our international partners, we have confirmed that there is sufficient propellant onboard the ISS to maintain nominal operations through the end of this year. With the docking of the Progress re-supply spacecraft on February 4 (ISS Flight 10P), the crew has sufficient supplies to remain on the ISS through June without additional re-supply. As we move beyond June, however, potable water availability becomes the constraining commodity. We are currently working closely with our Russian partner, Rosaviakosmos, to explore how best to address this issue on future near-term ISS re-supply missions. A Soyuz spacecraft (ISS Flight 6S) that brought the Expedition 7 crew to the ISS will remain docked and serves as a rescue vehicle for crew return in the event of a contingency. These Soyuz spacecraft have an on-orbit lifetime limitation of approximately 200–210 days, and must be replaced periodically.

The ISS, now in its third year of human occupancy, represents an important milestone in history. Due to this capability, humans are now able to permanently occupy the realm outside of Earth and are actively conducting ambitious research spanning such scientific disciplines as human physiology, genetics, materials science, Earth observation, physics, and biotechnology.

Columbia was the orbiter that was to have been used for the 4th servicing mission of the Hubble Space Telescope (HST) planned for November 2004. NASA can continue to service the HST, and any Orbiter is capable of supporting HST servicing missions. Furthermore, the HST is performing well, and is a robust observatory in no immediate need of servicing. Should a delay in the planned servicing mission occur that impacts the Telescope's ability to perform its science mission, HST can be placed in safe mode until a servicing mission can be arranged.

ANTICIPATING A RETURN TO FLIGHT

We have begun prudent and preliminary planning efforts to prepare for "return to flight" in order to be ready to implement the findings of the Columbia Accident Investigation Board. NASA's "Return to Flight" analysis will look across the entire Space Shuttle Program and evaluate possible improvements for safety and flight operations that we were considering prior to the Columbia accident. I have selected Dr. Michael A. Greenfield, Associate Deputy Administrator for Technical Programs, to lead our Return to Flight team along with William Readdy, Associate Administrator for Space Flight. This team will be composed of a number of key officials and safety professionals from within the space flight community. Their experience in shuttle operations and the investigation to date will provide a sound foundation for this critical activity.

FISCAL YEAR 2004 BUDGET REQUEST

On that sunny Saturday morning, February 1st, as I awaited the landing of the Columbia, I was contemplating my return to Washington, D.C., to prepare for the release of NASA's fiscal year 2004 budget. We had worked aggressively over the past year to develop a new Strategic Plan and fashion a budget to make it a reality. I was excited about announcing these plans with the release of the President's fiscal year 2004 Budget in two days. I had no idea how that tragic morning would change my focus over these ensuing weeks. During the days that followed, I was asked whether the Columbia accident would force us to toss aside our budget and long-range plans. Mr. Chairman, I will tell you as I told them, I think not. A test of any long-term plan is whether it can accept the inevitable setbacks and still achieve its goals. That is my hope for our plan.

Mr. Chairman, in light of the recent tragic loss of Columbia, we must recognize that all exploration entails risks. In this, the Centennial Year of Flight, I am reminded of an accident that occurred just across the river at Ft. Myer in 1908 on-

board the Wright flyer. The Wright brothers were demonstrating their flying machine to the U.S. Army, and a young lieutenant was riding as an observer. The flyer crashed, and Lt. Thomas Selfridge died of head injuries, thus becoming the first fatality of powered flight. From that accident in 1908 came the use of the crash helmet. So too from Columbia we will learn and make human space flight safer.

Although the budget proposal was prepared prior to the loss of Columbia and its crew, I am convinced that NASA's fiscal year 2004 budget proposal is responsible, credible, and compelling. It is responsible by making sure that our highest priorities are funded; it is credible by ensuring that adequate budget is built into the most technically challenging programs, and that we will fully account for the costs of all our programs; and, it is compelling by allowing NASA to pursue exciting new initiatives that are aligned with our strategic objectives. As I mentioned previously, the President's fiscal year 2004 budget request for NASA is $15.47 billion. While I will not rule out potential adjustments to this proposal that may be appropriate upon completion of the independent Gehman Board investigation, I look forward to discussing the fiscal year 2004 budget request and how it advances our mission goals of understanding and protecting the home planet, exploring the Universe and searching for life, and inspiring the next generation of explorers, and, in so doing, honoring the legacy of the Columbia astronauts.

ESTABLISHING OUR BLUEPRINT

Today's discussion is about more than changes in the budget—which is usually just a discussion over how one might change a few percent of one's budget from the year to year—but instead it is about a new strategic direction for NASA and how we are planning to shift our resources toward our longer-term goals. In April 2002, I gave a speech at the Syracuse University that espoused a new Vision and Mission for NASA. There are only 13 words in NASA's Vision and 26 words in NASA's Mission, but every word is the product of extensive senior leadership debate within NASA. And what you see in our new Strategic Plan is the product of those discussions, and the product that the entire NASA team is committed to delivering for the American people. Indeed, we did not need to release this Strategic Plan with our budget—after all, the law stipulates September 2003—but we felt that if we are serious about our Vision and Mission, we must have it during our budget deliberations and release it simultaneous with our budget.

NASA's strategy for the future represents a new paradigm. In the past, we achieved the marvel of the moon landing, an incredible achievement that has shaped much of NASA today, driven by a great external event—the Cold War—that allowed our Nation's treasury to be aggressively spent on such a goal. Today, and in the decades since Apollo, NASA has had no comparable great external imperative. This, however, does not mean that we cannot lift our eyes toward lofty goals and move up the ladder—using the stepping stones we have identified. We believe that we can make great strides in our exploration goals—not on some fixed timescale and fixed location—but throughout our solar system with ever more capable robotic spacecraft and humans to enable scientific discovery. Hence, we will not be driven by timeline, but by science, exploration, and discovery. We will pursue building blocks that provide the transformational technologies and capabilities that will open new pathways. We can do this within our means. And if someday there is an imperative or new discovery that pushes us further, we will be ready and well along the way.

To be successful, we will transform ourselves as follows:

—All investments will contribute to our goals and traceable to the Vision and Mission. Every NASA program and project must be relevant to one or more of the goals, and perform successfully against measures.

—Human space flight capabilities will be enhanced to enable research and discovery. We will continue to expand human presence in space—not as an end in itself, but as a means to further the goals of exploration, research, and discovery.

—Technology developments will be crosscutting. We will emphasize technologies with broad applications, such as propulsion, power, computation, communications, and information technologies.

—Education and inspiration will be an integral part of all our programs. We will track performance of our education programs like that of any other NASA activity.

—We will operate as One NASA in pursuit of our Vision and Mission. We will reinforce the shared commitment of all NASA employees to our common goals.

—As Only NASA Can: We will pursue activities unique to our Mission—if NASA does not do them, they will not get done—if others are doing them, we should question why NASA is involved.

STRENGTHENING OUR FOUNDATION

This building block and stepping stone approach already has one important brick in place: the fiscal year 2003 Omnibus Appropriations Act, signed by the President on February 20. The fiscal year 2003 appropriation contains many of the needed elements that will help NASA address important constraints in power, transportation, and human capabilities. The fiscal year 2003 budget contains funding for NASA's:

—Nuclear Systems Initiative to develop new power and propulsion technologies that will enable solar system exploration missions that are inconceivable with current conventional chemical propulsion systems. This initiative has been incorporated in Project Prometheus as part of our fiscal year 2004 Budget request.

—International Space Station (ISS), including full funding to assure we can successfully reach the milestone of U.S. Core Complete—which will enable accommodation of International Partner elements—maintain progress on long-lead items for enhanced research, and continue to build out this research laboratory platform for overcoming human limitations in space. It also includes authority to proceed with establishment of a Non-Governmental Organization (NGO) for ISS research. This funding and authority builds on our major achievements over the past year. We have received endorsements by two independent cost teams that deemed the program's cost estimates as "credible" and the ISS Management and Cost Evaluation (IMCE) independent task force, chaired by Tom Young, that commended our progress against their recommended management reforms. We have revamped our science program towards the highest priority research as identified by the Research Maximization and Prioritization (ReMAP) independent task force. We have put in place a new management team to control program content, ensure science requirements are met, and refocus program from development to operations. Finally, we are implementing new financial management tools to better manage our resources.

—Integrated Space Transportation Plan (ISTP) that will address our Nation's near and mid-term requirements in human space flight by making investments to extend the Shuttle's operational life for continued safe operations; developing a new Orbital Space Plane to provide a crew transfer capability as early as possible to assure access to and from the International Space Station; and, funding next-generation launch vehicle technology in such areas as propulsion, structures, and operations. Since providing our ISTP as part of the fiscal year 2003 budget amendment in November 2002, we have moved out aggressively on this roadmap. We are refining the Shuttle's Service Life Extension Program to better identify priorities and long-term investments. We also have completed top-level requirements for the Orbital Space Plane Program and awarded contracts to address priority technologies and areas of risk. Finally, we are refining our investments in long-term launch technologies as part of our recently initiated space architecture activities. We believe the ISTP is a good plan, but we are committed to re-examining it if necessary in light of future investigation findings on Columbia.

We must ensure that we have a sound foundation—our people, processes, and tools—from which to build our programs. It is only from such a sound foundation that we can go forward to more ambitious plans. We have placed the highest priority on achieving the goals of the President's Management Agenda, which contain five Government-wide initiatives that promise to significantly improve our management foundation:

—*Human Capital.*—We have begun to implement our strategic human capital plan, including a tracking system to identify workforce deficiencies across the Agency. I will address this very important issue at the conclusion of my remarks.

—*Competitive Sourcing.*—We have achieved the government-wide, 15 percent competitive sourcing goal, and are pursuing, wherever feasible, new opportunities for competition, including the renewal of contracts.

—*Financial Performance.*—We have addressed all issues contained in the disclaimer opinion on NASA's 2001 audit and been given a clean opinion for 2002.

—*E-Government.*—We are addressing information technology security issues and reviewing and enhancing other IT capabilities.

—*Budget & Performance Integration.*—We are budgeting for the full cost of NASA's programs and have integrated our budget and performance plan starting with fiscal year 2004 Budget.

Mr. Chairman, I would like to specifically highlight NASA's newest Enterprise, Education. The Education Enterprise was established in 2002, to inspire more students to pursue the study of science, technology, engineering and mathematics, and ultimately to choose careers in those disciplines or other aeronautics and space-related fields. The new Enterprise will unify the educational programs in NASA's other five enterprises and at NASA's 10 field Centers under a One NASA Education vision. NASA's Education vision will permeate and be embedded within all the Agency's activities.

LINKING INVESTMENTS TO STRATEGIC PLAN

Simultaneously with the submission of the President's fiscal year 2004 budget request, we submitted to the Congress the Agency's new Strategic Plan, our Integrated Budget and Performance Document, and our Performance and Accountability Report. I believe the sweeping changes we are proposing in our fiscal year 2004 Budget represent the most ambitious in our history and will enable us to vastly improve our ability to align our investments with our goals, assess progress, and make sound economic and technical decisions based on accurate and timely information. These improvements include:

—*Budget Restructure.*—In response to our new Strategic Plan, we have restructured our budget. NASA's new Strategic Plan recognizes that we are organized by those Mission-driven activities that deliver our end products—Space Science, Earth Science, Biological and Physical Research, Aeronautics, and Education—and by those activities—International Space Station, Space Shuttle, Space Flight Support, and Crosscutting Technology—that enable our Mission-driven activities to succeed. To mirror the organization of activities in our Strategic Plan into mission-driven efforts and supporting capabilities, and to recognize the reality that there is no arbitrary separation between human and science activities, the fiscal year 2004 budget replaces the previous structure with two new appropriation accounts: Science, Aeronautics and Exploration; and, Space Flight Capabilities. For fiscal year 2004, the request includes $7.661 billion for Science, Aeronautics and Exploration and $7.782 billion for Space Flight Capabilities.

Furthermore, the budget is structured in 18 goal-oriented Themes, which aggregate programs to be managed as a business portfolio in pursuit of common goals and performance measures.

—*Full Cost Accounting and Management.*—In a landmark event, we have allocated all our costs by program areas. Throughout our history, NASA has treated the cost of institutional activities (personnel, facilities, and support) separate from the programs they benefit. This has made economic trades difficult to analyze. In this budget, we have placed all costs against programs so that, for the first time, we can readily determine the true total costs of programs and allow managers to make more efficient and effective choices.

—*Integrated Budget and Performance Document.*—We have revamped our Congressional justification with a new document that merges our restructured budget with our performance plan. The document highlights the 18 themes and associated performance measures. Moreover, it clearly identifies projects approved for full scale development, including promised cost, schedule, and technical parameters.

—*Integrated Financial Management System.*—After a decade of trying, we are successfully bringing online a new integrated financial management system. For the first time in the agency's history, we will have one financial system for all our Field Centers, a major step in our One NASA goal. The core financial module will replace the legacy systems at all our Centers by this summer. This new system implementation is critical for enabling successful management of the budget, cost, performance, and the accounting changes mentioned above. Moreover, this new system will significantly enhance our ability to maintain a clean financial audit opinion.

PURSUING CRITICAL NEW OPPORTUNITIES

At NASA, we are developing building blocks that open new pathways of exploration and discovery. Today, our telescopes peer billions of years into the past to witness the beauty and unlock the mysteries of the early universe. Our satellites view the entire planet from space, allowing us to study global change and its consequences for life on Earth. Our spacecraft travel throughout the solar system and into the uncharted territories beyond, exploring the processes that have led to the incredible diversity of the planets and the emergence of life. Our aeronautics research has given people the routine ability to travel safely and reliably all around

the world. Our astronauts are living and working in space, and from them, we are learning how to expand our sphere of exploration far beyond the bounds of Earth.

But, our ability to fully achieve our Mission is constrained by the need for new technologies that can overcome our current limitations. We must provide ample power for our spacecraft as well as reliable and affordable transportation into space and throughout the solar system. We must deploy innovative sensors to probe Earth, other planets, and other solar systems. We must be able to communicate large volumes of data across vast distances, so that we can get the most from our robotic explorers. And we must learn to mitigate the physiological and psychological limitations of humans to withstand the harsh environment of space.

To address these and other challenges, we must build upon the strategic investments we are making in the fiscal year 2003 Budget and pursue critical new opportunities. Consequently, our fiscal year 2004 Budget request includes nine new initiatives:

—Project Prometheus will use breakthrough nuclear propulsion and power systems to fuel an ambitious mission to Jupiter's icy moons, which astrobiologists believe could harbor organic material, and lay the groundwork for even more ambitious exploration missions in the coming decades. The fiscal year 2004 budget request includes $93 million for this initiative, and $2.07 billion over five years.

—Human Research Initiative will conduct biomedical research and develop technologies to enable safe and efficient long-duration space missions, including potential future missions beyond low-Earth orbit. This initiative will provide knowledge and technology for efficient life support on the ISS, and has potential medical benefits for millions here on Earth. The fiscal year 2004 budget request includes $39 million for this initiative, and $347 million over five years.

—Optical Communications Initiative will invest in revolutionary laser communications technologies that will allow planetary spacecraft to transmit large volumes of scientific information, and will be demonstrated on a Mars mission in 2009. The fiscal year 2004 budget request includes $31 million for this initiative, and $233 million over five years.

—Beyond Einstein Initiative will launch two Einstein Observatories: LISA (Laser Interferometer Space Antenna), a deep-space-based gravity wave detector that will open our eyes to the as-yet-unseen cosmic gravitational radiations; and Constellation-X, a mission that will tell us what happens to matter at the edge of a black hole. In addition, the fiscal year 2004 budget request provides funding to initiate Einstein Probes, three spacecraft that will answer: "What powered the Big Bang?" (the Inflation Probe); "How did black holes form and grow?" (the Black Hole Finder Probe); and, "What is the mysterious energy pulling the Universe apart?" (the Dark Energy Probe). The fiscal year 2004 budget request includes $59 million for this initiative, and $765 million over five years.

—Climate Change Research Initiative is an interagency effort to accelerate research targeted at reducing key scientific uncertainties to help the Nation chart the best course forward on climate change issues. The fiscal year 2004 budget request includes $26 million for this initiative, and $72 million over five years.

—Aviation Security Initiative will develop technologies to help reduce the vulnerability of aviation to terrorist and criminal attacks. The fiscal year 2004 budget request includes $21 million for this initiative, and $225 million over five years.

—National Airspace System Transformation Augmentation will accelerate the development of technology to help address efficiency, capacity and security needs. The fiscal year 2004 budget request includes $27 million for this initiative, and $100 million over five years.

—Quiet Aircraft Technology Acceleration will develop technology to help significantly reduce community noise impact and achieve significant savings in amelioration programs. The fiscal year 2004 budget request includes $15 million for this initiative, and $100 million over five years.

—Education Initiative includes funding for NASA's Educator Astronaut Program (EAP), NASA Explorer Schools, NASA Explorer Institutes, and Scholarship for Service. As NASA's EAP approaches the April 30, application deadline, NASA has received more than 1245 EAP applications. The fiscal year 2004 budget request includes $26 million for this initiative, and $130 million over five years.

While there has been additional funding provided to NASA's previous five-year budget runout to provide for these new initiatives, the balance of the funds for the initiatives has resulted from reprioritization of future funding to more appropriately pursue the Agency's Vision/Mission and goals. These initiatives will plant the seeds to enable future achievements. From them, we will continually advance the boundaries of exploration and our knowledge of our home planet and our place in the universe. We seek answers along many paths, multiplying the possibilities for major

discoveries. The capabilities we develop may eventually enable humans to construct and service science platforms at waypoints in space between Earth and the Sun. Someday, we may use those same waypoints to begin our own journeys into the solar system to search for evidence of life on Mars and beyond.

Mr. Chairman, as I indicated above, there is one additional point that I wish to make. I would like to briefly discuss the state of our workforce, the lifeblood of this Agency. Last year, NASA submitted to the Congress a series of legislative proposals to help the Agency reconstitute and reconfigure our workforce. These provisions, for the most part, mirrored tools contained in the President's proposed Managerial Flexibility Act, and three of them have since been enacted on a Government-wide basis in the Homeland Security Act. NASA's workforce is an aging workforce. At the time of Apollo 17, the average age of the young men and women in Mission Control was 26 years; today, we have three times as many personnel over 60 years of age as under 30 years of age. Within five years, nearly 25 percent of NASA's current workforce will be eligible to retire. Since 1999, there have been at least 18 studies and reports concerning the workforce challenges facing NASA. The potential loss of this intellectual capital is particularly significant for this cutting-edge Agency that has skills imbalances.

Chairman Boehlert introduced H.R. 1085, the NASA Flexibility Act, which provides many of the human capital provisions that we feel are critical in our ability to reconstitute and reconfigure the NASA workforce. We support those provisions that are identical to the NASA human capital legislation submitted by the Administration in the last Congress; I am hopeful that these provisions will be enacted expeditiously this year, and ask for the Subcommittee's support of these important proposals.

In addition, the Senate Subcommittee on Oversight of Government, Management, Restructuring and the District of Columbia of the Committee on Government Affairs held a hearing on March 6 on NASA's workforce challenges, and the Committee is moving forward with S. 610, which is critical to NASA's ability to reconstitute and reconfigure our workforce. We support those provisions that are identical to the NASA human capital legislation submitted by the Administration in the last Congress; I am hopeful that these provisions will be enacted expeditiously this year, and ask for the Subcommittee's support for these important proposals.

Mr. Chairman, appended to my testimony, as Enclosure 1, is a chart displaying NASA's fiscal year 2004 five-year budget request. Also appended, as Enclosure 2, is a summary of the significant progress that NASA has made in the past year on a number of important research and exploration objectives, and a detailed summary of NASA's fiscal year 2004 budget request.

The Columbia accident has reminded me that we cannot stop dreaming. We cannot stop pursuing our ambitious goals. We cannot disappoint future generations when we stand at the threshold of great advances. Mr. Chairman, I believe that NASA's fiscal year 2004 budget request is well conceived and worthy of the favorable consideration by the Subcommittee. I am prepared to respond to your questions.

ENCLOSURE 1.—NATIONAL AERONAUTICS AND SPACE ADMINISTRATION PRESIDENT'S FISCAL YEAR 2004 BUDGET REQUEST

(Budget authority, dollars in millions)

By Appropriation Account/By Enterprise/By Theme	Business as Usual Pres. Bud. Fiscal Year 2003	Full Cost						Chapter Number
		Est. Pres. Bud. Fiscal Year 2003	Fiscal Year 2004	Fiscal Year 2005	Fiscal Year 2006	Fiscal Year 2007	Fiscal Year 2008	
Science, Aeronautics & Exploration	7,015	7,101	7,661	8,269	8,746	9,201	9,527	SAE SUM 1
Space Science	3,414	3,468	4,007	4,601	4,952	5,279	5,573	SAE 1
Solar System Exploration	976	1,046	1,359	1,648	1,843	1,952	2,054	SAE 2
Mars Exploration	496	551	570	607	550	662	685	SAE 3
Astronomical Search for Origins	698	799	877	968	1,020	1,022	1,061	SAE 4
Structure & Evolution of the Univ.	331	398	432	418	428	475	557	SAE 5
Sun-Earth Connections	544	674	770	959	1,111	1,169	1,216	SAE 6
Institutional	370	.....	.....	.....	.....	.....	.....	
Earth Science	1,628	1,610	1,552	1,525	1,598	1,700	1,725	SAE 7
Earth System Science	1,249	1,529	1,477	1,440	1,511	1,606	1,629	SAE 8
Earth Science Applications	62	81	75	85	87	94	96	SAE 9
Institutional	318	.....	.....	.....	.....	.....	.....	
Biological & Physical Research	842	913	973	1,042	1,087	1,118	1,143	SAE 10
Biological Sciences Research	245	304	359	399	453	456	481	SAE 11
Physical Sciences Research	247	351	353	392	380	409	401	SAE 12
Commercial Research & Support	170	254	261	251	254	253	262	SAE 13
Institutional + AM + SAGE	181	3	.....	.....	.....	.....	.....	
Aeronautics [1]	986	949	959	932	939	934	916	SAE 14
Aeronautics Technology	541	949	959	932	939	934	916	SAE 15
Institutional	445	.....	.....	.....	.....	.....	.....	
Education	144	160	170	169	169	170	170	SAE 16
Education	144	160	170	169	169	170	170	SAE 17
Space Flight Capabilities	7,960	7,875	7,782	7,746	7,881	8,066	8,247	SFC SUM 1
Space Flight	6,131	6,107	6,110	6,027	6,053	6,198	6,401	SFC 1
Space Station	1,492	1,851	1,707	1,587	1,586	1,606	1,603	SFC 2
Space Shuttle	3,208	3,786	3,968	4,020	4,065	4,186	4,369	SFC 3
Space Flight Support	239	471	434	419	402	407	429	SFC 4
Institutional	1,192	.....	.....	.....	.....	.....	.....	
Crosscutting Technologies [1]	1,829	1,768	1,673	1,720	1,828	1,868	1,846	SFC 5

ENCLOSURE 1.—NATIONAL AERONAUTICS AND SPACE ADMINISTRATION PRESIDENT'S FISCAL YEAR 2004 BUDGET REQUEST—Continued

(Budget authority, dollars in millions)

By Appropriation Account/By Enterprise/By Theme	Business as Usual Pres. Bud. Fiscal Year 2003	Full Cost						Chapter Number
		Est. Pres. Bud. Fiscal Year 2003	Fiscal Year 2004	Fiscal Year 2005	Fiscal Year 2006	Fiscal Year 2007	Fiscal Year 2008	
Space Launch Initiative	879	1,150	1,065	1,124	1,221	1,257	1,224	SFC 6
Mission & Sci. Measurement Tech.	275	434	438	435	439	439	444	SFC 7
Innovative Tech Trans. Partnerships	147	183	169	161	168	172	179	SFC 8
Institutional	528	.....	.....	.....	.....	.....	.....	
Inspector General	25	25	26	28	29	30	31	IG
TOTAL	15,000	15,000	15,469	16,043	16,656	17,297	17,806	
Year to Year Increase (in percent)	.....	.....	3.1	3.7	3.8	3.8	2.9	

[1] Aerospace Technology Enterprise includes both Aeronautics and Crosscutting Technologies.

NOTE: May not add due to rounding.

ENCLOSURE 2

SUMMARY—NASA ACCOMPLISHMENTS DURING 2002 AND FISCAL YEAR 2004 BUDGET REQUEST

NASA has made significant progress during 2002 on a number of important research and exploration objectives. During the past year, NASA:

—Captured a dramatic new portrait of the infant universe in sharp focus. NASA's Wilkinson Microwave Anistropy Probe revealed the first generation of stars that began shining only 200 million years after the big bang and forecasted the age of the universe at 13.7 billion years old. Most striking though was the probe's discovery that the universe will probably expand forever.

—Upgraded the Hubble Space Telescope on Columbia's mission (STS–109) in March 2002. Columbia's astronauts installed new solar panels, a better central power unit and a new camera that increased Hubble's "vision" tenfold, and revived a disabled infrared camera using an experimental cooling system.

—Celebrated Riccardo Giacconi's 2002 Nobel Prize in Physics for his pioneering NASA sponsored work in the field of X-Ray astronomy. This work has led to important discoveries about the nature of black holes, the formation of galaxies, and the life cycles of stars.

—Demonstrated a prototype device that automatically and continuously monitors the air for the presence of bacterial spores that may be used to detect biohazards, such as anthrax.

—Made progress on the development of a radar system for aircraft that detects atmospheric turbulence, thus improving prospects for commercial airliners to avoid the kind of bumpy weather most airline passengers find uncomfortable.

—Advanced technology to reduce airliner fuel tank fires or explosions, in our effort to make air travel safer and more secure.

—Began tests on a technology effort to develop lighter-weight flexible-wing aircraft.

—Measured through the Mars Odyssey spacecraft enough water ice buried deep under the poles of the red planet, that if thawed, could fill Lake Michigan twice over.

—Discovered for the first time, a planetary system, circling the nearby star 55 Cancri, with a Jupiter-sized planet at about the same distance for its parent star as our own Jupiter is from our sun. This discovery enhances the possibility that Earth-like planets could exist in such systems throughout the galaxy.

—Conducted Earth Science research that may one day allow public health officials to better track and predict the spread of West Nile Virus or similar diseases.

—Worked to develop cutting-edge technologies that will increase our weather forecasting capability from the current three-to-five-day accuracy level up to a seven-to-ten-day level within this decade.

—Observed the disintegration of the Antarctic Larsen Ice Shelf and the seasonal acceleration of the Greenland ice sheet.

—Encouraged thousands of students to learn more about space exploration through a nationwide contest to "Name the Rovers" that will launch toward Mars this year.

—Published, "Touch the Universe: A NASA Braille Book of Astronomy," a book that for the first time presents for visually impaired readers color images of planets, nebulae, stars, and galaxies. Each image is embossed with lines, bumps, and other textures. The raised patterns translate colors, shapes, and other intricate details of the cosmic objects, allowing visually impaired people to feel what they cannot see.

—Celebrated a second year of continuous human habitation on the International Space Station, the largest and most sophisticated spacecraft ever built, and continued assembly with four Space Shuttle missions.

—Reflecting the Agency's increased ISS research tempo, conducted approximately 48 research and technology development experiments aboard Station, including the first materials science research aboard Station, testing medical procedures for controlling the negative effects of space flight and increasing understanding of changes to bone and the central nervous system that occur in space. Astronauts conducted advanced cell culturing research, broke new ground in the study of dynamic systems, made up of tiny particles mixed in a liquid (colloids), and installed three new Station experiment equipment racks.

Space Science Enterprise

The Space Science Enterprise seeks to answer fundamental questions about life in the universe, including how it arose, its mechanisms, where in the solar system it may have originated or exist today, and whether there are similar planetary environments around other stars where the signature of life can be found. The Enterprise also seeks to understand how the universe began and evolved, how stars and galaxies formed, and how matter and energy are entwined on the grandest scale. The proposed fiscal year 2004 budget for the Space Science is $4.007 billion. The five theme areas in the Space Science Enterprise are:

Solar System Exploration

We are blessed to live in a fascinating neighborhood, one that we are getting to know better every day. This theme seeks to understand how our own Solar System formed and evolved and to determine if life exists beyond Earth.

The Administration's fiscal year 2004 budget request is $1,359 million. The budget request will support: the launch of the Deep Impact mission to probe below the surface of comet Temple-1 in January 2004; the Stardust spacecraft's January 2004 encounter with the comet Wild-2, and Stardust's return to Earth with dust samples from the comet in 2006; the March 2004 launch of the MESSENGER mission to explore Mercury, our least explored terrestrial planet; the arrival at Saturn of the Cassini spacecraft in July 2004, following a seven-year journey; and the return to Earth in September 2004 of the Genesis spacecraft with its samples of the solar wind following its two-year "sunbath". The budget also contains funding for the New Frontiers program to explore the outer planets in the Solar System and for Astrobiology research to improve our ability to find and identify potential life harboring planets.

We are very excited about two new Solar System Exploration initiatives that the budget will support. Building on the work of our Nuclear Systems Initiative, Project Prometheus is a new start to develop breakthrough power and propulsion technology that will lead to nuclear-powered spacecraft that will search early in the next decade for evidence of global subsurface oceans and possible organic material on Jupiter's three icy Galilean moons: Europa, Ganymede, and Callisto. Such advances in nuclear power and propulsion have set the stage for the next phase of outer solar system exploration.

Following in the same progress that led from Pony Express to Telegraph to Telephone, our Optical Communications initiative will use laser light instead of radio waves to revolutionize the way our spacecraft gather and report back information as they continue to scout the Solar System. Today, using conventional radio frequency communications, the Mars Reconnaissance Orbiter will take 21 months to map 20 percent of the red planet's surface. By contrast, optical communications would allow the entire surface to be mapped in four months. The budget will support a demonstration of the technology in 2009 using a Mars orbiting satellite that will relay data to high-altitude Earth balloons. If successful, this technology promises to achieve dramatic reductions in the cost per byte of data returned and could ultimately replace the Deep Space Network.

Mars Exploration

The Mars Odyssey spacecraft's discovery of large quantities of water frozen beneath the Mars' polar areas provides additional tantalizing evidence that our neighboring planet had a wet and warmer past. This water and hints of relatively recent liquid water flows make Mars the most likely place to seek evidence of ancient or present extraterrestrial life. Mars is also worth studying because much can be learned comparatively between the current and past geology, atmospheres, and magnetic fields of Earth with Mars. We also hope to advance our understanding of Mars because some day in the not so distant future, human explorers may take humanity's next giant leap to the Red Planet.

The proposed Mars exploration budget is $570 million. This request will support our goal of 90 days of surface operations of the twin Mars Exploration Rovers, set to begin in January and February of 2004 at sites where ancient water once flowed.

The budget also supports the continued development of: the Mars Reconnaissance Orbiter, a spacecraft that will map Martian surface features as small as a basketball in 2005; the Mars Science Laboratory, a rover that will traverse tens of kilometers over Mars in 2009 and last over a year, digging and drilling for unique samples to study in its onboard laboratory; and the telecommunications satellite that will demonstrate our laser light optical communications technology in 2009.

Astronomical Search for Origins

The astounding portrait of the infant universe captured by NASA's Wilkinson Microwave Anistropy Probe provides one more demonstration of the human capacity to probe more deeply into the mysteries of creation. This theme strives to answer two profound questions: Where did we come from? Are we alone? It does so by observing the birth of the earliest galaxies and the formation of stars, by finding planetary systems in our galactic neighborhood, including those capable of harboring life, and by learning whether life exists beyond our Solar System. One year may seem inconsequential in a Universe that is 13.7 billion years old, but as we learned during the last year, a great deal of knowledge and understanding can be obtained in the period it takes the Earth to orbit the Sun.

The Administration's proposed fiscal year 2004 budget request for the Astronomical Search for Origins is $877 million. The budget will provide funding for: continued operations of the Hubble Space Telescope; the development of the next-generation James Webb Space Telescope and the Space Interferometry Mission, a device scheduled for launch in 2009 that will increase our ability to detect planets around nearby stars; and initial science operations of the Space Infrared Telescope Facility, the final mission of NASA's Great Observatory Program. The budget was also designed to support the final Space Shuttle servicing mission to the Hubble Space Telescope, a mission that is now on hold pending the report of the Columbia Accident Investigation Board.

Structure and Evolution of the Universe

This theme seeks to understand the nature and phenomena of the Universe. It seeks to understand the fundamental laws of space, time and energy and to trace the cycles that have created the conditions for our own existence. This is accomplished in part by observing signals from the Big Bang, mapping the extreme distortions of space-time about black holes, investigating galaxies, and understanding the most energetic events in the universe. The theme also attempts to understand the mysterious dark energy that pervades the Universe and determines its ultimate destiny.

The proposed budget for this theme is $432 million, which will support development of the Gamma-ray Large Area Space Telescope, a mission to study high-energy objects like black holes.

The budget will also support a new initiative that will honor the continuing legacy of Albert Einstein, some 99 years after Einstein developed his theory of Special Relativity. The Beyond Einstein initiative will attempt to answer three questions left unanswered by Einstein's theories: What powered the Big Bang? What happens to space, time, and matter at the edge of a black hole? What is the mysterious dark energy expanding the Universe? Under the initiative, a Laser Interferometer Space Antenna will use three spacecraft "formation flying" five million kilometers apart in a triangle to observe the distortion of space due to gravity waves. Also, Constellation-X, an X-ray telescope 100 times more powerful than all existing X-ray telescopes, will use a team of powerful X-ray telescopes working in unison to observe black holes, investigate "recycled" stellar material, and search for the "missing matter" in the universe. Finally, the initiative will support Einstein Probes, a program that will begin later this decade, consisting of fully and openly competed missions (in the manner of the Discovery, Explorers, and New Frontiers programs) to conduct investigations that benefit science objectives within the theme.

Sun-Earth Connections

We should never take our life-sustaining Sun for granted. NASA's Sun-Earth Connections theme investigates our Sun and how its structure and behavior affect Earth. NASA seeks to understand how the variability of solar radiation affects Earth's climate, and how we can better predict solar flares that affect the upper atmosphere and can damage satellites and disable the power distribution grid on the ground. NASA also uses the Sun as an ideal laboratory for researching basic physics and learning how other stars function.

The proposed budget for NASA's Sun-Earth Connections theme is $770 million. The budget will support the development of the STEREO, the Solar Dynamics Observatory and future flight missions. Scheduled for a 2005 launch, STEREO will use two identically equipped spacecraft to provide revolutionary 3-D imaging of coronal mass ejections. The Solar Dynamics Observatory, which will study the Sun's magnetic field and the dynamic processes that influence space weather, will enter implementation of development in January 2004.

Earth Science Enterprise

In the near-half century that we have lived in the "space age" the most interesting planet that NASA spacecraft have explored is our own home in the universe. Spacecraft observations combined with atmospheric, ground-based and oceanic measurements have enabled a systematic study of Earth processes, leading to important scientific advances and tangible benefits to the American public. NASA's vision of "improving life here" starts with the Earth Science Enterprise's study of planet Earth from space. The Enterprise seeks to understand and protect our home planet by advancing Earth system science and applying the results to improve prediction of climate, weather, and natural hazards. The proposed fiscal year 2004 budget for Earth Science is $1,552 million. The two theme areas for Earth Science are:

Earth System Science

Within this theme, NASA is deploying and operating the first comprehensive constellation of Earth-observing research satellites designed to reveal interactions among Earth's continents, atmosphere, oceans, ice, and life. These interactions produce the conditions that sustain life on Earth. Data and information from NASA satellites enable researchers to understand the causes and consequences of global change and inform the decisions made by governments, businesses, and citizens to improve our quality of life.

The $1.477 million fiscal year 2004 budget request for Earth System Science will support the launches in 2004 of three complementary formation-flying polar orbiting satellites, which in effect will become a super-satellite. They are: AURA, which will study Earth's ozone, air quality and climate; Cloudsat, which will measure the structure of clouds to better quantify their key role in the Earth's water cycle and climate system; and CALIPSO, the NASA-French project to determine how the climate, aerosols and clouds interact. Calipso, coupled with Aura and an advanced polarimeter slated for launch in 2007 under an initiative to accelerate evaluation of non-carbon dioxide (CO_2) impacts on climate change as part of the Administration's Global Climate Change Research Initiative, will help determine the role of aerosols in climate, reducing one of the largest uncertainties in climate models.

Significantly, the Earth System Science budget will also provide $524 million, in conjunction with the administration's Global Climate Change Research Initiative, for research and modeling that will help answer critical scientific questions on climate change to aid policy and economic decision makers.

Other major Earth Science work in 2004 that the budget will support include: Using satellite observations to provide daily and seasonal global atmospheric water vapor, rainfall, snowfall, sea-ice and ice-sheet maps to improve the scientific understanding and modeling of water cycles throughout the Earth system; Improving the predictive capabilities of regional weather models through satellite-derived localized temperature and moisture profiles; and assimilating satellite and in situ observations into a variety of ocean, atmospheric, and ice models for the purpose of estimating the state of Earth's seasonal and decadal climate.

The budget will also support the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project under development in partnership with the National Oceanic and Atmospheric Administration and the Department of Defense. This project, slated for launch in 2006, will maintain the continuity of certain environmental data sets that were initiated with NASA's Terra and Aqua satellites, prior to the launch of the operational NPOESS system in 2009. Also supported with be the Landsat data continuity mission, an innovative program to seek partnerships with industry that use critical land remote sensing data.

Earth Science Applications

NASA recognizes that by working in partnership with other Federal agencies, we can leverage our research results and Earth observation information products to provide significant benefits to the American public. Within our Earth Science Applications theme we have identified applications where we can improve decision support systems, such as weather prediction models and near-airport terrain databases operated by our partner agencies. For each application, joint research and demonstration projects are under way or being developed. We are also developing crosscutting solutions that advance the use of NASA information and technology across a range of potential new applications.

The $75 million fiscal year 2004 budget request for Earth Science Applications will support a focus on 12 specific applications of national priority where other agencies' decision support systems can be markedly improved based on NASA-provided data and information. In 2004, NASA intends to benchmark improvements to air quality and agricultural productivity and competitively select projects for the Re-

search, Education, Applications Solutions Network (REASON) program to serve national priorities.

Biological and Physical Research Enterprise

On their 16-day mission of exploration and discovery the seven Columbia astronauts conducted medical investigations related to cancer, osteoporosis and kidney stones, all with the goal of advancing our understanding of nature and the world we live in. The research operations were smooth and productive, with new phenomena being observed in combustion science and in cell science. As Commander Rick Husband said, "I think one of the legacies of NASA is that you always push forward. And STS–107 is doing that on the science side—pushing human science knowledge forward."

Our Biological and Physical Research Enterprise exists to push the frontiers of science forward. The Enterprise uses the rich opportunities provided by space flight to pursue answers to a broad set of scientific questions, including those about the human health risks of space flight. The space environment offers a laboratory, unique in the history of science, that allows the study of biological and physical processes. Experiments that take advantage of this environment extend from basic biology to quantum mechanics and from fundamental research to research with near-term applications in medicine and industry.

The proposed fiscal year 2004 budget for Biological and Physical Research is $973 million. The three theme areas in Biological and Physical Research are:

Biological Sciences Research

Within this theme, NASA determines ways to support a safe human presence in space. We are conducting research to define and control the physiological and psychological risks posed to human health by exposure in space to radiation, reduced gravity, and isolation. This theme also conducts research and development to improve the performance of life support systems. It includes a basic biology research component that seeks both to pursue fundamental biological research questions from cell to tissues to whole organisms which produce results that can support advanced methods for enabling the continued human exploration of space.

The proposed $359 million fiscal year 2004 budget for Biological Sciences Research will fund expanded ground research into how humans can adapt to the hazards of space flight for unprecedented periods of time under a new Human Research Initiative. A flight program in high priority areas of advanced human support technology to reduce mass to orbit and beyond for life support equipment by a factor of three is also funded by this Initiative.

Physical Sciences Research

This theme supports research that takes advantage of the unique environment of Space to expand our understanding of the fundamental laws of nature. We also support applied physical science research to improve safety and performance for human exploration and research that has applications for American industry.

Activities in this theme are structured to respond to the Research Maximization and Prioritization Task Force process, undertaken last year to prioritize BPR research activities. The budget request of $353 million will support major space flight hardware development for physical sciences research on the International Space Station, while reducing funding for lower priority areas such as biomolecular technology, and structural biology future facility class space flight hardware, and level II program management support. The budget will increase funding for research of strategic importance to NASA's long range-goals, including radiation protection and basic research enabling knowledge for power and propulsion technologies. The budget also contains funding for our new Human Research Initiative, with funds targeted for spacecraft system innovations such as less massive fluid and thermal control methods and fire safety improvements.

In 2004, the budget supports the preparation of the first major Physical Sciences Research facility rack to the International Space Station, and the beginning of prime research facility operations on the Space Station.

Research Partnerships and Flight Support

The Research Partnership element of this theme establishes policies and allocates space resources to encourage and develop research partnerships in the pursuit of NASA missions and Enterprise scientific objectives. This research supports product development on Earth and leverages industry resources to accelerate progress in our strategic research areas. Ultimately, Research Partnerships may support development of an infrastructure that can be applied to human exploration.

A majority of the proposed $261 million budget in fiscal year 2004 for Research Partnerships and Flight Support will apply to the Flight Support element of this

theme. The Flight Support element will be augmented by two activities: (1) the transfer of the Alpha Magnetic spectrometer program management and budget from Physical Sciences Research; and, (2) the consolidation of the Enterprise Support program content and budget, previously diffused across various programmatic components. The Flight Support activity includes multi-user hardware development, payload integration and training, and payload operations support.

The budget also provides for the restructuring of NASA's Space Product Development program by aligning industrial partnerships with NASA mission needs and Enterprise scientific objectives. We intend to review our existing Research Partnership Centers to determine which of these will be retained.

Aerospace Technology Enterprise

The Aerospace Technology Enterprise contributes to the NASA Vision by pioneering and developing advanced technologies. These technologies, in turn, improve the air transportation system, access to space, and science missions. This Enterprise also develops technology partnerships with industry and academia outside traditional aerospace fields. The Aerospace Technology Enterprise is comprised of four themes:

Aeronautics Technology

NASA's Aeronautics Program develops technologies that can help create a safer, more secure, environmentally friendly and efficient air transportation system, increase performance of military aircraft, and develop new uses for science or commercial missions. This theme also enhances the Nation's security through its partnerships with the Department of Defense (DOD) and Federal Aviation Administration (FAA) and the Department of Homeland Security. Research areas include advanced propulsion technologies, lightweight high-strength adaptable structures, adaptive controls, advanced vehicle designed, and new collaborative design and development tools. In collaboration with the FAA, research is conducted in air traffic management technologies for new automation tools and concepts of operations. Major funding allocation includes three technology initiatives in aviation security, airspace systems, and quiet aircraft.

The fiscal year 2004 budget request for Aeronautics is $959 million. It includes $169 million for Aviation Safety and Security projects, $217 million for Airspace Systems, and $574 for Vehicle Systems. The budget request includes funding for three new initiatives:

—*Aviation Security.*—The budget includes $21 million for this new initiative ($225 million over five years); it will develop technology for commercial aircraft and airspace protection, including development of damage-tolerant structures and autonomous and reconfigurable flight controls technology to prevent aircraft from being used as weapons and to protect against catastrophic loss of the aircraft in the event of damage from sabotage or explosives.

—*National Airspace System Transition.*—The budget includes $27 million for this new initiative ($100 million over five years); it will enable technology, in cooperation with the FAA, to transition to a next-generation National Airspace System that would increase the capacity, efficiency, and security of the system to meet the mobility and economic-growth needs of the Nation, reducing delays and increasing air transportation efficiency.

—*Quiet Aircraft Technology.*—The budget includes $15 million for this new initiative ($100 million over five years); it will accelerate development and transfer of technologies that will reduce perceived noise in half by 2007 compared to the 1997 state-of-the-art.

Space Launch Initiative

The objective of the Space Launch Initiative is to ensure safe, affordable, and reliable access to space. Funding is focused on a new Orbital Space Plane for crew rescue and transfer capability, and on the Next Generation Launch Technology program for advanced kerosene engine development and hypersonic propulsion research and testing. The fiscal year 2004 budget request is fully consistent with the fiscal year 2003 Budget Amendment submitted to Congress in November 2002.

The fiscal year 2004 budget request includes $1.065 billion for SLI, including $550 million for the OSP to develop a crew return capability from Space Station by 2010 and crew transfer capability atop an expendable launch vehicle by 2012. Funding will support technology demonstrators such as X–37 and advanced design studies. The budget request also includes $515 million for the Next Generation Launch Technology Program to meet NASA's future space launch needs. Funding includes advanced kerosene engine development and hypersonic propulsion research and testing.

The budget envisions several key events in 2004:

—Test flight of DART vehicle to demonstrate autonomous rendezvous technology between a chase vehicle and an on-orbit satellite;
—Drop test of X–37 vehicle from carrier aircraft to demonstrate autonomous landing capability as a precursor to a possible orbital demonstration; and,
—Preliminary design review of OSP to support a full-scale development decision.

Mission and Scientific Measurement Technologies

This Theme develops crosscutting technology for a variety of aviation and space applications. Funding is focused on communications, power and propulsion systems, micro-devices and instruments, information technology, nanotechnology, and biotechnology. These technology advances will have the potential to open a new era in aviation and allow space missions to expand our knowledge of Earth and the universe.

The fiscal year 2004 budget request is $438 million, which includes $233 million for Computing, Information, and Communications Technologies, $44 million for Engineering for Complex Systems, and $161 million for Enabling Concepts and Technologies.

Innovative Technology Transfer Partnerships

This theme develops partnerships with industry and academia to develop new technology that supports NASA programs and transfers NASA technology to U.S. industry. The fiscal year 2004 budget request introduces a creative partnership program to sponsor dual use technologies, called Enterprise Engine, and is discontinuing the existing centralized commercial technology promotion efforts and, instead, recompeting and refocusing our technology transfer programs across the Enterprises to maximize benefits to NASA and the taxpayer.

The fiscal year 2004 budget request is $169 million, which includes $5 million for the Enterprise Engine, $33 million for recompeting and refocusing technology transfer efforts to maximize benefits, and $131 million for the SBIR/STTR programs.

Education Enterprise

Education is NASA's newest Enterprise, established in 2002, to inspire more students to pursue the study of science, technology, engineering and mathematics, and ultimately to choose careers in those disciplines or other aeronautics and space-related fields. The new Enterprise will unify the educational programs in NASA's other five enterprises and at NASA's 10 field Centers under a One NASA Education vision. NASA's Education will permeate and be embedded within all the Agency's activities.

NASA's Education Program will provide unique teaching and learning experiences, as only NASA can, through the Agency's research and flight capabilities. Students and educators will be able to work with NASA and university scientists to use real data to study the Earth, explore Mars, and conduct other scientific investigations. They will work with NASA's engineers to learn what it takes to develop the new technology required to reach the farthest regions of the solar system and to live and work in space. It is important that the next generation of explorers represents the full spectrum of the U.S. population, including minority students and those from low-income families. To ensure the diversity of NASA's workforce, our educational programs pay particular attention to under-represented groups. NASA Education will support our 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 to seek NASA careers.

The fiscal year 2004 budget request of $170 million includes $78 million for education programs including the continuation of pipeline development programs for students at all educational levels with the continuation of Space Grant/EPSCOR programs and $92 million for Minority University Research and Education. It also includes $26 million for an Education Initiative that encompasses the Educator Astronaut Program, NASA Explorer Schools Program, Scholarship for Service, and Explorer Institutes.

Space Flight Enterprise

International Space Station

This theme supports activities for continuing a permanent human presence in Earth orbit—the International Space Station. The Space Station provides a long-duration habitable laboratory for science and research activities to investigate the limits of human performance, expand human experience in living and working in space, better understand fundamental biological and physical processes using the unique environment of space, and enable private sector research in space. The Space Station allows unique, long-duration, space-based research in cell and development biol-

ogy, plant biology, human physiology, fluid physics, combustion science, materials science, and fundamental physics. It also provides a unique platform for observing the Earth's surface and atmosphere, the Sun, and other astronomical objects.

The Space Station program is well on its way to completing work on the U.S. Core Complete configuration, which will enable accommodation of International Partner elements. Flight elements undergoing ground integration and test are proceeding on schedule, and the last U.S. flight element is scheduled for delivery to NASA by the spring of 2003. Fiscal year 2004 funding drops as planned, as development activities near an end, and on-orbit operations and research becomes the focus of the program. The budget maintains proposals reflected in the fiscal year 2003 Budget Amendment, including additional funds for reserves and funding for Node 3 and the Regenerative Environmental Control and Life Support System (ECLSS). The budget continues significant progress toward resolving the Space Station management and cost control issues that confronted the program at the end of 2001. Many changes based on recommendations of the ISS Management and Cost Evaluation (IMCE) task force have increased NASA's confidence in achieving success with the U.S. Core Complete station. Management changes have been made to ensure that ISS capabilities are driven by science requirements, and to make appropriate decisions as the program moves from development into operations.

Space Shuttle

The Shuttle, first launched in 1981, provides the only capability in the United States for human access to space. In addition to transporting people, materials, and equipment, the Space Shuttle allows astronauts to service and repair satellites and build the Space Station. The Space Shuttle can be configured to carry different types of equipment, spacecraft, and scientific experiments that help scientists understand and protect our home planet, explore the universe, and inspire the imagination of the American people.

Fiscal year 2004 budget request of $3.968 billion supports the planned steady state flight rate of 5 launches per year beginning in fiscal year 2006. It provides $379 million (and $1.7 billion over five years) for the Space Shuttle Service Life Extension Program, which will improve safety and infrastructure needs to allow flying of the Space Shuttle well into the next decade.

Space and Flight Support

The fiscal year 2004 budget request of $434 million supports space communications, launch services, rocket propulsion testing, and advanced systems. Funding is provided for cleanup of the Plumbrook facility and tracking and data relay satellite follow-on studies. The overall funding level reflects the planned transfer of certain space operations responsibilities to other Enterprises.

Senator BOND. Thank you very much, Mr. Administrator. I'm going to yield my time to the Chairman of the full committee, Senator Stevens.

STATEMENT OF SENATOR TED STEVENS

Senator STEVENS. Thank you very much, Mr. Chairman. I'm delighted to have an opportunity to be here with the Administrator. I do have a couple of comments and we look forward to working with you, my good friend.

I note the reduction in aeronautics allocation and the reduction in the educational allocation as compared to 2003. This is the 100th anniversary of manned flight. We are, I think, in a position where we ought to demonstrate to the world that we recognize the great impact of that flight, and I hope that we're not going to be eliminating some of the research that from my point of view is extremely vital to the future of aeronautics.

For instance, there was a research project going on trying to find out a way to deal with the sonic boom. I haven't heard about that for several years. Currently we cannot fly across the land mass with commercial aviation beyond the speed of sound because of the impact of the sonic booms.

We also have in terms of the education program a series of initiatives that have inspired young people to consider a career in space, and your agency. I'm one that firmly believes that the dreams and desires that you form as a child, even at the 5th, 6th or 7th year, are the ones you want to pursue for the rest of your life, and I think it's highly important that we continue that stimulus through the education programs. I will be interested to see how you are going to allocate the decrease within your department, because I do hope that we maintain the concepts that we need for that.

My only question to you, though, if I may ask a question right now is, what are you going to do about the Wright brothers celebration in December?

Mr. O'KEEFE. Thank you, Mr. Chairman, I appreciate it. We are always guided by your superior wisdom in these respects, no doubt about it.

Senator STEVENS. Not wisdom, inquiry.

Mr. O'KEEFE. As it pertains to aeronautics, again, in the coming year there is a 5 percent increase. What is really the question is the out-year projections. In working with Marion Blakey at the FAA, I think we will see some change in that. So our out-year projections will be fine here when we go back and take a look at it. But we really kind of held that as a baseline in order to develop this effort in concert with the FAA to specifically look at aeronautics improvements on a variety of different issues. For 2004 it's an increase up and we will continue on.

DOD/FAA/NASA TASK FORCE

Senator STEVENS. Some time ago I suggested that there be sort of a task force between DOD, FAA and NASA, to insure that there would not be a redundancy, that there would be a sharing of effort in the future aspects of aeronautics research. I hope that continues.

Mr. O'KEEFE. Yes, sir, absolutely. As a matter of fact, that's precisely where we're going. Marion Blakey will be leading that, I will be participating, along with Dr. Ron Sega from Defense, and the three agencies and departments involved in this are hitting the ground exactly the way you talked about it. That's why I think the out-year numbers at best are a place holder baseline that I anticipate we will adjust as a consequence of the efforts that come out of this effort that Marion is putting together now.

On the education front, I need to get some numbers for the record, because our intent was to increase and increase dramatically in terms of the education focus, and the activities we're involved in. We have a lot of outreach programs as well as support for a range of the other eight nonprofit or nongovernment organizations that are really dedicated to a research and education focus. The educator astronaut issue, so forth, have all been designed to specifically stimulate that kind of interest for precisely the age group you're talking about. If you don't catch folks in that middle school, junior high kind of focus area, they are likely not to want to pursue math, science, engineering, technology-related activities. So we spend a lot of time really focusing our energies on that age group more than any other, because in many respects that's where the formulative kind of ages are really based in terms of a pursuit of those kind of professional opportunities in the time ahead. So,

we're concentrating on that an awful lot, and we will provide some better information for you. I think we will have an opportunity later this afternoon to get together on this issue, and I will make sure I bring that with me.

Senator STEVENS. Good. I would like to see something in the record on that.

Mr. O'KEEFE. Yes, sir, absolutely.

[The information follows:]

ACADEMIC PROGRAMS

NASA requested $153.7 million in fiscal year 2002 for Academic programs. However, during the appropriations process, Congress added a one-time increase of $73.6 million for 20 separate Congressional interest projects for that year. The fiscal year 2004 request of $169.8 million is in full cost, and includes a $10 million increase in education funding for the new initiatives described in the agency request.

Senator STEVENS. Thank you, Mr. Chairman.

Senator BOND. Thank you, Senator Stevens.

Senator MIKULSKI. Senator Stevens, before you go, one thing you should know that Senator Bond and I did last year to increase graduate students going into the science field. Working with Senator Bond through the National Science Foundation, we provided graduate student stipends in the basic science, physics, chemistry, for $18,000 a year. This year we raised it to $22,000 and Dr. Colwell said there was a 30 percent increase in the number of American graduate students interested in going to graduate school in these fields. So we're working on this and we want to talk with you about it.

Senator STEVENS. Good, thank you.

Senator BOND. We need a bigger allocation.

Senator MIKULSKI. We need a bigger allocation, right.

Senator BOND. Senator Mikulski.

Senator MIKULSKI. Senator Bond, why don't you go right ahead? We afforded the courtesy to the chair of the committee, but why don't you lead it off?

Senator BOND. Thank you, Senator. Shuttle costs.

Senator MIKULSKI. Senator Stevens is emeritus. I mean, he goes first no matter what. He is A and you're A–1.

Senator BOND. No, we're all equal but he's just a little more equal.

SHUTTLE COSTS

Potential shuttle costs, what funding requirements do you anticipate in 2003 and 2004 to respond to the Columbia accident for repairing the space shuttle, slips in the space station, shuttle, changes in the research? I know we don't have a final, but do you have a ballpark guess or an estimate of what that might be?

Mr. O'KEEFE. As it stands right now, the recovery effort has largely been covered by the Federal Emergency Management Agency as a consequence of their disaster relief allotment or allocation that the Congress provides each year. That's going to total something on the order of about $235 million is the current estimate, that FEMA is using to reimburse the U.S. Forest Service, the EPA, other Federal agencies, and the State and local government activities. Our costs at NASA are well within the $50 million incre-

mental cost differences that the Congress provided funding for in the fiscal year 2003 appropriation made in February.

Our efforts primarily are in support of, again, the Columbia Accident Investigation Board, and within that allocation, that will cover the incremental differences as we move to current. In total cost for all activities, if we added everything we did in this, it would probably——

Senator BOND. Just NASA.

Mr. O'KEEFE. Yes, sir. Again, within that $50 million you provided, I think we're going to cover that as an incremental cost difference and that's going to work. To the extent there is any incremental costs above that, we will be back to testify on what that will take, but it's really not, at this juncture we think it's going to be well within it on an incremental marginal cost basis.

The differences in shuttle and Station, right now we're not incurring any costs, because the fleet is grounded. So the expense to continue in a ready status, the ability to return to flight as expeditiously as we can, is well within the allocations that have been made for shuttle launches, as well as International Space Station, where we are processing the modules as we have been in order to ready for that return flight as soon as we can get there.

ISS'S RESUPPLY MISSIONS

Senator BOND. The International Space Station's resupply missions, I understand the partners have yet to come up with a final agreement on how to provide $100 million for additional Russian vehicles. I would like to know what the status is of discussion with the other partners regarding how to fund the Russian production and will they be able to provide the needed funding or are we going to have to ask for a waiver from or amendment to the Iran Nonproliferation Act so that NASA can provide some of the funding?

Mr. O'KEEFE. Well, as you mentioned in your opening statement, sir, the actions are speaking louder than anything else. The Russians launched the Soyuz rocket, and Ed Lu and Yuri Malenchenko not only launched successfully, they are there on International Space Station today. Ken Bowersox, Don Pettit, Nikolai Budarin will come back on the Soyuz. The Progress flights that were planned, the unmanned logistics resupply flights that are planned, there's one going up in June, there is another we're seeking to accelerate into November. All those are going exactly according to the plan and the Russians have stepped up in a very substantial way.

I'm leaving tomorrow to go welcome home Don, Ken and Nikolai, and I will spend a little time with Yuri Koptev, who is the head of the Russian Space Agency. I do not anticipate any requirements to waive or consider the Iran Nonproliferation Act. The partners are acting like partners.

ORBITAL SPACE PLANE

Senator BOND. Good. Well, given the fact that we are so dependent on the Russians, the orbital space plane would provide an alternate mode to the Russian vehicle and to the shuttle for taking crews and a limited amount of cargo to the Space Station. To what extent can development of the orbital space plane be accelerated so

the capability is available as soon as possible, and what's your current estimate for the cost of the orbital space plane?

Mr. O'KEEFE. Currently, I just went through an exercise here in the last couple of weeks to try to look at all the acceleration options that may be possible. It turns on two things. The first one is, there are competing designs, there are at least three major contractors who have different approaches on how to deal with what is a very short list of requirements. We have kept this very minimal. You can list all the requirements for the orbital space plane on a single page. There isn't any ambiguity about what it is we're looking for in terms of its requirements and capabilities we seek it to perform at.

Now depending on what kind of approach those various contract proposals may come back with here in the next 9 months, that will tell us a lot more about how fast or how slow it's going to be in terms of delivery. In terms of overall cost, I wouldn't want to compromise their ingenuity, imagination or creativity one dime until we see what they come up with.

Senator BOND. Okay, I got that answer. Senator Mikulski.

RETURN TO FLIGHT

Senator MIKULSKI. Thank you, Mr. Chairman.

Mr. O'Keefe, when do you think the shuttle will fly again? I understand that NASA announced it was taking interim steps to prepare a return to flight before the Gehman Commission had finished its final report.

Mr. O'KEEFE. What we announced is we are making preparations now to return to flight as early as the end of this calendar year, so we can be in a position if all the findings and recommendations come forward, and do not impede that opportunity, we will not be in a position when the report comes out to say well, I guess now we ought to start thinking about returning to flight. We are trying to do all the preparation work in order to do that, and we are implementing their findings and recommendations.

Senator MIKULSKI. Well, here's my question, because I don't think the Gehman report is going to be done until July, and I don't want to go rushing back into flight. I think when we go, we have to be sure in the most meticulous, arduous way that we are ready to go and therefore, turn to the lessons learned from the Gehman Commission not only to what went wrong, but the other issues addressed.

But to go back to the question now with respect to preparing for launching, first, how are you preparing, and second, not only from the technical and engineering and safety aspects, but are you preparing in terms of money? In this President's budget request, NASA only gets $55 million more. That's just slightly above 2003.

Here is my worst fear from a financial standpoint. We have the Gehman report in July and we've already marked up and we're already meeting down on our flight plan. There is a substantial price tag to being ready to return to flight. How do we get it in the appropriations bill and if we don't, then we cannot have that whole issue of NASA going to other important programs to get the money like they did when the station was running such horrific cost over-

runs. And congratulations to you for bringing about that discipline there.

So you see what I'm worried about, one, that we really know how to go back to flight and that we are able to correct the mistakes. And at the same time, where is the money going to come from and when will it come? Because we have to be talking about it now. Do you have estimates, could you elaborate?

Mr. O'KEEFE. Thank you, Senator. Well, first and foremost, 110 percent, we will not fly again until we can satisfy ourselves that we can do so safely. We are not rushing to that objective. What we are doing is preparing ourselves to assure that we implement the findings and recommendations which are starting to come out now from the Gehman board, as expeditiously and as thoroughly as we possibly can, to make absolutely certain we tack down every prospect of what's necessary and what they're observing as changes necessary to return to safe flight.

So, if we're diligent about that and if there are no hardware process showstoppers in this, we anticipate we could be looking at the early part of next fiscal year of flying again. Between now and then, we'd planned six flights for this fiscal year. We only conducted two, STS–113 and STS–107.

Senator MIKULSKI. So you have money in the pipeline?

Mr. O'KEEFE. Yes, ma'am.

Senator MIKULSKI. Because I have other questions.

Mr. O'KEEFE. Absolutely. So that is there, we're not expending the cost of launch services as a result of that.

Senator MIKULSKI. So you anticipate that you are not going to need additional funds?

Mr. O'KEEFE. No, I didn't suggest that. But you will find right now, in order to prepare for flight as soon as we get the full report and understand all the finding of what's going on, and we will be receiving those over the course of the next 2 months, we may be in a position to better estimate what that will take, and advise the Congress.

Senator MIKULSKI. Do you have any concept now, or are you reluctant to say?

Mr. O'KEEFE. I have not even a parameter of what the cost difference will be relative to how much we have in the budget today. Until we really get the findings and recommendations from the board, it really does not lend itself to that. The only things we have right now are an estimate, for example, on differing options and——

PRESIDENT'S BUDGET REQUEST

Senator MIKULSKI. I understand. Let me just say this. I am very troubled by the President's budget request. I think it is status quo, and I think we needed another $500 million more, one, to catch up with a tattered infrastructure, the things that got worn well before you came, and two, a banking of what we might need for the shuttle based on the recommendations.

So to only have $55 million and not in the President's budget request, we are really going to be shackled in terms of how to proceed here. And we don't want you to short change these other items that you listed, very worthwhile projects, some exciting, some crucial to

saving lives of not only astronauts but here on Earth. We like where you're heading, but I'm afraid we are going to be heading for a real fiscal issue on the appropriations process.

And then also, thanks to the Russians, having their Soyuz that's worked as a lifeboat in space, but Russia is a financially-strapped country. That's why Senator Bond asked how we can reimburse them so that the money goes to the space agency and is not scattered through the other Russian financial problems.

So I'm very concerned that we support what you need to do, and have the wherewithal, that we help the Russians meet their responsibilities and the spirit in which they pay for it. And I know my time is up, but you see where I'm going.

I also have a lot of questions about Hubble, staffing, and the infrastructure.

Mr. O'KEEFE. If I could, Mr. Chairman, just kind of real quick, the budget we submitted on February 3 is empirically about $460 million more than what the President requested the year before. Congress acted on that request weeks later. So what you have observed here is absolutely accurate, relative to the appropriation that the Congress enacted weeks after this budget was submitted to you at the time, it was again, $450-odd million difference, versus the difference of $100 million now, as a consequence of what the Congress did enact during the course of the subsequent enactment as part of the omnibus appropriations bill. We will continue to look at this. I assure you, our intent is not to rob other programs in order to pay for shuttle costs. That will not be in the mix. Not the intent, won't do it.

Senator BOND. Thank you very much, Sean. Senator Craig.

STATEMENT OF SENATOR LARRY E. CRAIG

Senator CRAIG. Mr. Chairman, thank you. I will be brief, I have to run to another committee, but I did want to stop by and say hello to Mr. O'Keefe. Again, thank you, I appreciate the visit we had at NASA earlier this year.

I know you have all been tragically busy since that time, and of course I think all of us are very anxious for the report to be completed and to get our shuttles flying again under all of the conditions that are safe and appropriate. Because clearly, I think the combination of the advancement in the space agenda and our science agenda, it plays such a key role and is critical.

And slowly but surely, this Congress is shifting a little bit toward the physical sciences again, and I'm very pleased about that. We have expended a great deal in the biological sciences and we're proud of that, but we also recognize that we need to push the other envelope a bit more than we have.

I would suggest you take a look at a bill that just came out of the Energy Committee, Director O'Keefe, as it relates to your nuclear systems initiative. We hope this Congress and certainly this administration, is moving in a new direction again as it relates to nuclear reactors and new passive safe reactors, and of course coupling with the Navy is appropriate for where you want to go and I think most appropriate, the efficiencies that we have achieved there are exciting. But GEN–4 reactors and new advance fuel cell technology may well couple with what we want to do, what you

want to do out there in space with that kind of power plant that should be able to be done effectively and in a miniature or small way that we're looking at.

So hopefully we can move this agenda with the cooperation of our colleagues. It is a bold one and this administration appears to want to be bold in that area, and I am confident that a good many of us now do.

Recognizing the importance of that, we're going to couple that particular project with hydrogen electrolysis creation, and so we hope to get this Congress looking forward to new energy instead of standing still.

Of course, your mention of radiation as I was coming in is important to all of us. As you know, the University of Idaho has played a great role and our colleagues there and their association with you in radiation, hardening electronics. So I'm excited that we advance that. We learned something about the ability to protect our tools, now we ought to be able to learn something about the ability to protect our people a little more in the appropriate way.

And lastly when we get the shuttle flying again, your educator in space program flies with it, and that is exciting. Our friend Barbara Morgan from Idaho plays a key role in that, and thank you again for allowing her what she does so well. Those are all important to us.

But I'm hoping this committee and this administration will stay high on what we're doing because it is important to the future of our country. And if we don't think what we do has application across the board for the pushing of the sciences and technology, it just got demonstrated so effectively in another part of the world that sets us apart as a unique country. But our willingness to use those technologies for mankind's betterment is also demonstrated largely. So, thank you for your work and I will be here encouraging and working with our Chairman and our Ranking Member to make sure the resources are available. Thank you.

Mr. O'KEEFE. Thank you, Senator. I appreciate your support.

Senator BOND. Thank you very much, Senator Craig. Senator Shelby.

INTEGRATED SPACE TRANSPORTATION PROGRAM

Senator SHELBY. Thank you, Mr. Chairman.

I believe NASA's integrated space transportation plan contains three important and critical elements for our Nation's future in space, the shuttle life extension, the orbital space plane, and the Next Generation Launch Technology Program.

Given that the Next Generation Launch Technology Program, NGLT, is largely a technology development program, is it at risk for becoming a real player for any cost overruns associated with the shuttle life extension program or the orbital space plane?

Mr. O'KEEFE. I don't believe so.

Senator SHELBY. You don't?

Mr. O'KEEFE. I think in the time not too far ahead, we will be seeing greater definition for the next generation launch technology. We're working very, very closely with the Defense Department in order to get a partnered and joint program kind of effort that's compatible to assure access to space and launch access, which is

their concern as well, that I think we will really put some definition on that. Our intent will certainly be to have that be a program that stands on its own. We're looking at that to be the mantra that we intend to live by.

LAUNCH TECHNOLOGIES—NASA/DOD

Senator SHELBY. What about NASA's unique needs and DOD's requirements? What kind of challenges do you have there and how do you address those challenges?

Mr. O'KEEFE. The efforts that really are very common between Defense and NASA are for launch technologies. The various approaches, whether they be horizontal or vertical in terms of the efforts that can be carried out, one of the ways is we're working to identify where those common technologies really have greatest application is through the national aerospace initiative that Dr. Ron Sega is championing, to really emphasize our partnering arrangements with them on hypersonics, and a range of very specific structures and propulsion initiatives they have pursued that we're doing jointly with them. That becomes the areas where I think our greatest leverage of each other's capability can really be expanded in order to see some specific yield for both NASA and DOD.

EXPLORER PROGRAM

Senator SHELBY. On February 3 of this year, NASA released an announcement of opportunity for the explorer program focused on small explorers and missions of opportunity. I have been told that despite Marshall's experience in development and management of science spacecraft, that this announcement of opportunity prevents Marshall from having a project management or end-to-end systems engineering role. If that's true, this announcement of opportunity doesn't track with what I understand to be NASA's philosophy and your philosophy of one NASA.

Mr. O'KEEFE. Yes, sir.

Senator SHELBY. Are you familiar with that announcement?

Mr. O'KEEFE. No, sir, I'm not. Let me look into it and get back to you.

Senator SHELBY. Will you check on that and get back to us?

Mr. O'KEEFE. Yes, sir.

[The information follows:]

SMALL EXPLORER MISSION (SMEX)/MISSION OF OPPORTUNITY

NASA's Announcement of Opportunity (AO) released on February 3, 2003, for a Small Explorers Mission (SMEX)/Mission of Opportunity included the following language:

"For free-flyer SMEX missions, if project management and end-to-end systems engineering are to be implemented from a NASA center, then these functions must be performed by one of the centers designated by the Office of Space Science: either the Jet Propulsion Laboratory (JPL) or the Goddard Space Flight Center (GSFC) . . .".

The language included in this Announcement of Opportunity was consistent with a July 2002 Agency policy decision to limit project management and end-to-end systems engineering implementation for Space Science and Earth Science missions by a NASA Center to the Goddard Space Flight Center (GSFC) and the Jet Propulsion Laboratory (JPL). The July 2002 policy decision was based on a 1996 Zero Base Review recommendation to consolidate aerospace operations to fewer Centers, with the objective of consolidating engineering and test facilities, consolidating and aligning

functional management expertise, and strengthening science programs, consistent with the NASA Procedure and Guideline (NPG) 1000.3 concerning the NASA Organization.

GSFC and JPL are recognized by both the Space Science and Earth Science Enterprises as mission-implementing Centers for management and system design and implementation of space missions. GSFC and JPL have strong foundations in this area, and have made substantial and distinct investments to provide such expertise and services in the future. The Marshall Space Flight Center (MSFC) is the Agency's Center for space transportation systems development, microgravity research, and optics manufacturing technology. MSFC provides leadership in the areas of management and implementation of research, technology maturation, design, development, and integration of space transportation and propulsion systems, including Space Shuttle propulsion element improvements, reusable launch vehicles, vehicles for orbital transfer and deep space missions, and qualification verification of new expendable launch vehicles.

The July 2002 Agency policy decision was not intended to prevent Centers other than GSFC and JPL from proposing as Principal Investigators, or proposing hardware, software, etc., in response to NASA Announcement of Opportunities; in fact, those Centers are encouraged to do so.

Nevertheless, the Agency is currently in the process of re-examining and re-validating the policy. We will apprise the Committee of the results of this effort upon its conclusion.

PROPULSION RESEARCH

Senator SHELBY. We appreciate that very much.

We know that you're developing a portfolio of propulsion research in both earth-to-orbit applications and in space applications. Can you describe the balance that you're trying to strike between the two investments here and what challenges you see on the horizon for each one of these activities?

Mr. O'KEEFE. Yes, sir. The first, I think, as we discussed a moment ago in terms of launch technologies, primarily the next generation launch technologies is a focused part of the space integration plan, so much of what you see there is not commingled or in competition with the in-space propulsion effort which is almost, well, largely focused on the Project Prometheus effort. It is both power generation and propulsion capabilities. There's an awful lot of effort and energy on both fronts, but they are not again, they're being looked at as separate propositions. One is, how do you accomplish the rate of 8½ minutes into low-earth orbit, which is our launch technology, as well as then once there, how do you find any in-space propulsion capability, of which we have none right now?

The only capability we have, however limited, I shouldn't say none, is we use gravity assist, we really hope to get into the right orbit pattern in order to head anywhere in this solar system is about the best we can do, that uses a very, very limited kind of solar electric generated power source.

The capabilities, just to give you a context of that, that must be utilized on any mission for a spacecraft, unmanned particularly, has to have a maximum power generation yield of no more than two 60-watt light bulbs. So this room would be max energy they have never had anywhere. With the nuclear systems effort and the power Project Prometheus would provide, is about 100 times this kind of power generation capability in order to, incidentally, provide for propulsion of any variety——

Senator SHELBY. That's a big leap, isn't it?

Mr. O'KEEFE [continuing]. Of power generation, but also the ability to sustain the science and research force. These are two very

distinct approaches that we're taking to this. They are not in competition with each other at all.

Senator SHELBY. Mr. Chairman, I have some other questions but I will wait my next turn.

PROJECT PROMETHEUS

Senator BOND. Thank you, Senator Shelby.

Mr. Administrator, speaking of Prometheus, I have some questions about it. You have shown in your request about $3 billion needed for the first 5 years, 2004 to 2008. But I understand the head of NASA's Space Science Office, Dr. Wyler was quoted in Science Magazine recently as saying the cost of Prometheus through 2012 would be $8 to $9 billion. And of course unfortunately, we know the preliminary cost increases are never overblown.

I am concerned about whether this project is going to consume such a large amount of the space science funding that other initiatives are funded, or are not going to be funded. What percentage of the funding is for building spacecraft and what for building nuclear power and propulsion systems, and could the costs be lowered by building less ambitious spacecraft since you know, since this is the first shot and if something goes awry, we don't want to lose it. Give me a little idea of your cost containment on this.

Mr. O'KEEFE. Yes, sir. The budget before you are the numbers I stand by and they are through the next, at that 5-year span, a little over $3 billion for the development effort for nuclear propulsion and power generation capabilities. It also begins the first demonstrator, if you will, of that capability, which will provide around Jupiter's moons a mission in the early part of the next decade, a multiple on-orbit pass.

For example, if you look at the number of on-orbit passes we can go, it would probably take you the better end of 10 to 20 missions. If each one of them costs some number of hundreds of million dollars, multiply it by that number and that's how much it would take in order to pursue this. So this is going to be significantly less expensive to pursue as multiple on-orbit efforts at various planetary objects than anything we could do elsewhere. We get one fly-by on every other spacecraft, one, and if the cameras don't work, the instrumentation isn't right, whatever, it's a lost mission entirely.

So this is an approach to really enhance the capability to do many, many fly-bys, get there a lot faster, do it in a more expeditious period of time, and the development cost in this next 5 years is that much. Then from there on, each of the individual missions are going to be stand-alone costs. In the case of the Jupiter moons project which will be the first demo of that capability, which is due to launch towards the end of the decade, beginning of next, that will be an estimate we will refine over the course of the next year or so, when we will be able to provide a much more authoritative number of what that's going to cost. In terms of development expenses, it's $3.5 billion.

ORBITAL SPACE PLANE

Senator BOND. And then you've got the orbital space plane, that could be another $3 billion, so you have some big ticket items. Are

you sure you aren't going to be squeezing something? OMB is going to have to start smiling on you and us a lot more kindly if you're going to get all these done.

Mr. O'KEEFE. Well, the 5-year plan that's projected as part of this request has the Agency submission rising to nearly $18 billion by the end of fiscal year 2008, I believe it is. This is fully funded, that's the total estimate we believe it's going to take to do everything in there. This is the President's budget request, so everybody is in agreement with what those numbers say. So as a consequence, if he stands by them, I sure can stand by them because he's put his imprimatur on it.

RECRUITING AND RETENTION

Senator BOND. I have been very much concerned, as Senator Mikulski is, about the staffing of NASA and making sure that we have the right people. I know we are facing a significant shortage. We need a home-grown new generation of engineers and scientists. There's a retirement crisis coming, and there is not an adequate pool now in the United States to meet the needs. So we are, as the Senator has said, working with NSF.

But I question whether NASA needs incentives to retain staff. To NASA's credit, the employees see themselves as part of the family and they don't seem to be leaving. But I am particularly concerned about buy-outs. Do we need additional buy-out authority if 25 percent of the current NASA work force is eligible for retirement within 5 years and there are not enough scientists and engineers to replace them? And so I ask, why do we need to hire them?

And I'm also concerned about buy-out authority because I understand that sometimes we buy out these employees, they leave and then go to work for a contractor at a higher salary, and we get to pay that salary after we've bought them out, we get to pay for a very wonderful high class scientist at a significantly increased rate. How are you going to protect against that problem? I kind of have a different view of solutions for solving your staffing needs.

Mr. O'KEEFE. Thank you, Mr. Chairman. Indeed, the personnel management approaches that can be taken, the full range of those tools was requested in the President's legislation he submitted last June to follow through with that. It is recruitment, it's retention, and it's also professional development. All the authority we need on buy-outs and so forth, I concur with you. I think we need to be very targeted on how we do that, and use it under very limited circumstances. Right now, retention is a better approach. The catch is, we're faced with an actuarial reality which is, I represent the average age of the agency. I am 47. There are three times as many scientists and engineers who are over 60 as we have under 30. So no matter how long I try to retain folks under any set of circumstances, an actuarial reality is going to set in here and in some specific core competence fields like again, nuclear engineers for example, we know we're going to need more of them in the time ahead.

We have a current retirement rate that is hovering around the 50 percent range that will be eligible in the next 3 years. So not only do you need more folks in certain competencies, you also need folks who are going to replace the seasoned veterans that are there

before they actually depart. So the approach we're really looking to is heavy on the recruitment side, heavy on the professional development end of the folks that are there now, mid-level entry of some of the people who have a decade of experience with an engineering firm of comparable nature to come in and be part of that pool, and then some selected targeted kind of retention efforts in order to keep that talent base around.

But again, as an actuary, there are a lot of folks who simply aren't going to stay beyond a certain level. We're not really as anxious to look at moving people out as bringing folks in in a timely enough manner to make that effective. So any combination of the President's proposal, the Voinovich bill, the House bill, whichever ones you like, please vote early and often for any of those. We could use any of those tools. We are right now strapped to the position we are limited to at present.

Senator BOND. Thank you very much, Mr. Administrator. I have reached the end of my useful life cycle today and I am going to turn the hearing over to Senator Mikulski and then to Senator Shelby to continue as long as they wish. I look forward to reading at some later date the rest of your testimony and I thank you for your testimony today.

Senator Mikulski.

Mr. O'KEEFE. Thank you, Mr. Chairman. I appreciate your courtesy, as always.

HUBBLE SPACE TELESCOPE

Senator MIKULSKI [presiding]. Mr. Administrator, my questions are going to be specific because the time is moving along.

I want to go to the Hubble and the consequences of what's happened because of Columbia to the Hubble. Columbia was supposed to service the Hubble telescope in 2004. The question is will it be able to do that? Will we be able to accommodate Hubble servicing missions; will we be able to extend the life of Hubble because it needs servicing? Can you describe to me the consequences to the Hubble because of the Columbia accident?

And second, what then would be the consequences to the appropriations request?

Mr. O'KEEFE. Thank you, Senator. The budget for fiscal year 2005 will cover the November 2004 launch of the servicing mission that was planned. As soon as we get back to safe flight operations, we will assess that timing to determine if that date or other, we won't just shift it to the right, but we will continue that servicing mission as soon as we need to in order to make sure Hubble stays viable.

You're exactly right. It's an unbelievable instrument. Here it is 13 years later, considered to be something 13 years ago that would be just a big pile of space junk has turned into the miracle that it is today in the astronomy community. So, there is no question we want to sustain that, and we will look at a servicing mission as soon as we return to safe flight.

The pacing item is, there are four gyros that are aboard Hubble right now, they're all operational. We need at least three to operate in the pattern that it's in. So if we see a failure at any point in the near future, we may have to look at how fast that servicing

mission has to be conducted. The next mission in November 2004 had been planned to take six gyros up, replace them all out, and so that becomes the big pacing item, in addition to a number of other things we do on Hubble as well, but we will do that as soon as possible, independent of the International Space Station flight schedule.

Senator MIKULSKI. We need to be kept posted on that.

Mr. O'KEEFE. Yes, Senator.

ASSOCIATED UNIVERSITIES RESEARCH ASSOCIATES (AURA)

Senator MIKULSKI. My other question is, the Hubble, in terms of the information captured by Hubble to Goddard, to a group called AURA, the Associated Universities Research Associates, which is an NGO operating on the Hopkins campus in very modest circumstances. I understand that they had a contract to run this work for about 10 years, but NASA has told them that they might want to recompute the last 2 years of the contract. I'm puzzled by that.

I'm not against competition and certainly you know that, from our other conversations, but could you tell me why NASA would want to do that, because it places uncertainty for their ability to retain really brilliant astrophysicists, et cetera, and also even to negotiate proper leases, and so on.

Mr. O'KEEFE. Let me look at the very specific case here as soon as I get back to the shop to figure out what the focus on this one, or the AURA competition effort is all about.

But as a general matter, I think exactly as you mentioned, it is very much part of our persistent view of saying let's always look at competitive alternatives, just if for no other reason than to satisfy ourselves that the way we're doing it today is a good way of doing it, let's retain that, but let's look at alternative sources.

Senator MIKULSKI. Well, I understand that, and I know that you're also looking at an NGO for the International Space Station methodology. I think the genius of what has kept NASA so fresh and spectacular has been we have a core group of civil servants, we've discussed that in terms of the aging workforce, but it's combined with private contractors, again, who delivered, they brought freshness and best practices, and what a private sector brings. Then they work with universities, but also these groups.

Now AURA is not part of Hopkins, though it's on the campus, but again, you have the retention of 300 people at stake. If you don't pick them up, they're cosmologists, astrophysicists, so many separate fields of physics that I couldn't even describe. And at the same time, they provide a very robust education program because Hubble, other than our human side, is the attraction to young people in space, what it provides to science centers and the like. So what they do in education with what the Genius Club finds, is stunning.

So therefore, you could bust that wide open and at least 300 people that know what to do with Hubble information and also what to do about education, the magnet that we want it to be, and then how they can also get best value in terms of what they need to procure. So, could you get back to me on that?

Mr. O'KEEFE. Yes, ma'am, absolutely.

Senator MIKULSKI. Again, I don't want to take a position because I don't know all the facts, but do think you ought to look at it, because we don't want to create uncertainty just for saying we want to compete, because there is importance to competition.

Mr. O'KEEFE. Very good. I will take a look at it.

Senator MIKULSKI. Senator Shelby.

MICROGRAVITY RESEARCH PROGRAM

Senator SHELBY. Thank you. I will try to be brief, Mr. O'Keefe, and I appreciate your patience.

Would you describe the state of the microgravity research program within NASA? In particular, how would you describe the state of materials and biotech programs?

Mr. O'KEEFE. Yes, sir. The human research initiative that is part of our budget request is an effort to, again, aggressively look at what consequences microgravity poses, in both physiological as well as physical sciences kinds of applications. The two areas that are really pretty staggering, and I'm not a scientist so I'm easily staggered on these kinds of things, and then maybe I'm not easily surprised, is you see growth in acceleration as well as dramatic deceleration or degradation of physiological conditions. You can grow certain cells in microgravity conditions faster, yet at the same time it degrades other aspects of physiologic condition.

We don't understand that. I haven't found a scientist yet who really can say gee, we can tell you exactly why this phenomenon occurs in both directions, some acceleration in one area and the degradation in others.

Senator SHELBY. It has great potential in one area and negative aspects in others, is that what you're saying?

Mr. O'KEEFE. Big time.

Senator SHELBY. But there has to be an answer.

Mr. O'KEEFE. Exactly. And so trying to crack that code is a big piece of what, you know, as a plebeian in this one by comparison, understanding exactly that is a long pole in a tent for any human space flight objective. We've got to understand what it takes in order to endure and persist in those kinds of conditions.

From a physical sciences side, we've made some remarkable efforts, even to include on STS–107, on the Columbia flight, on physical sciences and exactly how materials research can be conducted better in microgravity conditions.

But the focus as previously alluded, I think Senator Craig mentioned, is on International Space Station more dominant on the biological and physiology side of the equation, but there's an awful lot of physical materials research efforts that we are now looking to enhance once we get back to completing that laboratory condition that is really quite illuminating, it opens a whole range of doors if we can figure out just alone what that phenomenon is of both degradation as well as acceleration of cell growth, that would open up a lot of things that would have tremendous application.

Senator SHELBY. Microgravity research overall has great promise for some unanswered questions too, is that what you're saying?

Mr. O'KEEFE. Indeed. The other side of it too, I think is really critical to understand, microgravity research conducted in an earthbound laboratory, the best we have been able to do is sustain a

microgravity condition that even vaguely assimilates to what you see on orbit for about a month, and that's it, can't sustain anything longer than that. Whereas of course, it's a permanent condition on International Space Station as well as on shuttles. It has a phenomenon and a physiological consequence that is very different than any laboratory simulation we've created, bioreactors or something else.

Senator SHELBY. It's unique.

Mr. O'KEEFE. Very.

SPACE STATION RESEARCH PRIORITIES

Senator SHELBY. Recent language that was included in the 2003 omnibus appropriations bill directed NASA, and we know this is just a few months ago, to re-examine the space station research priorities on a regular basis instead of using the re-map recommendations as a one-time fix. Do you agree with the committee's direction there? Have you had time to evaluate that?

Mr. O'KEEFE. No, sir. We agree and concur entirely. There's no question. The efforts last summer was a start. It was the first time, I am very pleased to say, that we got all the scientists from all these different communities to sit down and agree to a priority. Until they met, everything was number one, everything was a top priority, and so as a consequence, nothing was a priority. We now have at least a baseline from which to make that determination. That means there are some elements of the scientific community that aren't as happy with their placement in that priority rank as others, but at least it's a beginning. So it needs to be reassessed and we fully, wholeheartedly agree with the committee's recommendations and instructions on a regular effort to constantly update that and make it contemporary for what we see in the development of International Space Station.

Senator SHELBY. Plus you have flexibility that way.

Mr. O'KEEFE. Yes, sir, absolutely.

NUCLEAR POWER PROPULSION

Senator SHELBY. You talked a minute ago regarding the development of nuclear-powered propulsion capability. I understand that the Jet Propulsion Lab, Glenn Research Center, and the Marshall Space Flight Center will play key roles in this program.

Mr. O'KEEFE. Indeed.

Senator SHELBY. And the field centers would contribute to the overall program?

Mr. O'KEEFE. Yes, sir. The start-off focus here is, the Jet Propulsion Laboratory (JPL), will primarily be a design house because of the nature of—they have handled all of the, essentially the batteries that are nuclear powered, the RTGs that we have used with the Department of Energy over the last 20-odd years, so they have done a lot of design work on that side. The Glenn Research Center will look at a lot of power generation capacities that we will need in order to harness that ability that nuclear reactors can produce to then generate power for the science and research activities. And Marshall is going to have a very strong lead in looking at a lot of the propulsion systems, as will Glenn, so the combination of both of them to perform the power generation and propulsion capabili-

ties will be very closely interrelated, so that you have something that generates power and uses it for different purposes. So the prowess of both of those centers is going to be essential, an understanding and cooperation effort between the two in order to ensure we have a power generation capability that's going to be at least a factor of 3 better than what it is today.

ADDITIONAL COMMITTEE QUESTIONS

Senator SHELBY [presiding]. Mr. Administrator, I think they've all abandoned us now, so I'm through with my questions. There might be some questions for the record by other members. We appreciate your appearance today, we appreciate your candor, and we apologize for the interruptions, but you know about interruptions since you worked here.

[The following questions were not asked at the hearing, but were submitted to the Agency for response subsequent to the hearing:]

QUESTIONS SUBMITTED BY SENATOR LARRY CRAIG

ULTRA-LOW POWER ELECTRONICS TECHNOLOGY

Question. In order to perform greater science as projected in the next generation programs planned by NASA, more computation, high data rates, and high data volumes are required which must be processed on-board a spacecraft, especially those in near-earth orbits. In deep space programs, including the Nuclear Initiative, mass is an important concern.

NASA has developed a Radiation Tolerant Ultra Low Power electronic technology, currently at a relatively low Technology Readiness Level (TRL), that appears to have significant promise in terms of performance and cost, according to engineers at the Goddard Space Flight Center and the NASA Institute of Advanced Microelectronics at the University of Idaho.

What plans does NASA have to bring this technology to maturity where it can be deployed into NASA programs?

Answer. NASA is continuing to fund a grant with the University of Idaho (valued at $0.6 million) in fiscal year 2003 for development of ultra-low power electronics technology. In July 2003, the Office of Aerospace Technology plans to issue an openly-competed $3 million NASA Research Announcement (NRA) to solicit proposals for development of radiation tolerant ultra-low power electronics. This NRA will fund approximately 10–15 research activities for 3 years. The technology development activities funded through the NRA are intended to advance the maturity of ultra-low power electronics to Technology Readiness Level (TRL) 5, which is laboratory demonstration of device operation in simulated space radiation environments. A variety of radiation-tolerant, ultra-low power components will be developed, including microprocessors, analog-to-digital converters, and application specific integrated circuits.

Many times NASA, and other Government agencies, create a program where a number of related technology developments are funded, but in the end they fail to meet the final objective to create technology that can be deployed into flight programs. In other words, a set of technology developments is created that is not integrated to produce a useful product.

Question. What steps is NASA taking to insure the development of the Radiation Tolerant Ultra Low Power electronics program is integrated to produce viable high TRL level technology for deployment within a few years?

Answer. Ultra-low power electronics components that have been matured in research activities funded by the NRA will be transitioned to the NASA Science and Space Flight Enterprises for integration into prototype flight systems and insertion into future missions. The strategy for accomplishing this transition is to identify potential mission applications, and to obtain agreements from the Enterprises to co-fund further development and system integration. A portion of Aerospace Technology program funding will be allocated for co-funding the transition of ultra-low power electronics technology to the Enterprises. The strategy of requiring co-funding from the Enterprise customers in combination with Aerospace Technology co-funding insures that the Enterprises are committed to using the technology in their missions. In addition, the investigators selected via the NRA will be teamed with a

NASA field Center (Goddard Space Flight Center or Jet Propulsion Laboratory) to insure that the development of electronic devices is focused on practical and near-term mission applications. The NASA Center will act as the bridge between the investigator and the Enterprise customer by integrating the electronic devices into prototype instruments and data systems. Validation of ultra-low power electronics technology in flight experiments such as those sponsored by the New Millennium Program will also be activity pursued.

QUESTIONS SUBMITTED BY SENATOR MIKE DEWINE

NEXT GENERATION TURBINE ENGINES

Question. NASA's plan is to reduce funding for aeronautics nearly 5 percent over the next 5 years. This is of significant concern to me. Further, there are key advancements in technology, such as intelligent propulsion systems, which are critical to fuel efficient and environmentally benign turbine engines. This engine technology needs to be demonstrated at an appropriate level so that industry can incorporate the technology into future engines. What are NASA's plans for advancement and demonstration of intelligent propulsion systems for next generation turbine engines?

Answer. The Vehicle Systems Program, and in particular, the Ultra Efficient Engine Technology (UEET) and Quiet Aircraft Technology (QAT) projects are developing the enabling turbine engine technologies that will allow U.S. industry to design and bring to market next generation commercial engines which will have unsurpassed levels of performance with significantly reduced levels of environmental impact (emissions and noise). In order to adequately reduce the risk of U.S. industry incorporating these technologies in future designs, plans are being developed to partner with industry and the Department of Defense (DOD) to conduct ground demonstrations of the highest priority (i.e. highest pay off) technologies. These tests will be conducted under cost sharing arrangements between NASA and the industrial/DOD partners. In addition, the UEET project is currently developing a limited portfolio of technologies, which will contribute to future intelligent propulsion systems. As these intelligent engine technologies are matured they will also be demonstrated in appropriate ground test demonstrations utilizing cost sharing arrangements. These intelligent engine technologies are being developed through partnerships with universities, industry, and DOD working with NASA research personnel.

PROJECT PROMETHEUS

Question. I strongly support NASA's Nuclear Systems Program to enable new science discoveries by using advanced power and electric propulsion systems. This includes the initiative started in fiscal year 2003 as well as the proposed acceleration called Project Prometheus.

Answer. The objectives of the Nuclear Systems Initiative proposed and approved in the fiscal year 2003 budget remain essentially the same, but the initiative has been renamed Project Prometheus. The only significant proposed programmatic change to the initiative for fiscal year 2004 is the commencement of the first mission to use Project Prometheus technology: the Jupiter Icy Moons Orbiter (JIMO).

Question. What are NASA's plans to insure that these critical power and electric propulsion technologies continue to be advanced and demonstrated?

Answer. Recognizing the enormous potential of this initiative, NASA has placed a high priority on advancing and demonstrating Project Prometheus power and propulsion technologies. We are committed to advancing these technologies by competitively tapping the talents, experience, and innovative minds within industry, academia, and other agencies of the U.S. government, such as the Department of Energy (DOE). We will also fully utilize the expertise and technical capabilities of several NASA centers in the areas of: electric thrusters; power conversion and power management; mission design, development and operations; large spacecraft structures and systems; engine and propulsion system design; and systems engineering and integration for complex programs.

Last year's budget included only a nuclear technology research program, with the first demonstration mission deferred until additional analysis indicated that such a mission was both highly desirable and likely to be technically feasible. That analysis has been undertaken and suggests that a revolutionary new science mission may well be feasible. The end result, JIMO, will allow NASA to demonstrate the technologies formulated within Project Prometheus. Future mission concepts will depend on developments in the years to come.

Question. What will be the role of NASA's Glenn Research Center in advancing, demonstrating and developing these systems?

Answer. NASA's Glenn Research Center will be involved in several aspects of management and technology development in Project Prometheus. The exact role over time will be based on the technologies identified as the most promising propulsion and power candidates as well as Glenn's focus within Project Prometheus, which is in the areas of power generation, power conversion, and electric propulsion technologies.

Glenn is already playing a key role in the research and development of advanced radioisotope power conversion. A major activity is the development of the Stirling Radioisotope Generator (SRG), a candidate power source for a 2009 Mars mission. Drawing on the expertise at Glenn, DOE, and the industry development team, the SRG will likely achieve a four-fold improvement in the power conversion efficiency over current radioisotope power sources. The SRG and other power conversion and propulsion technologies being developed will have application across a broad range of potential missions.

BIOLOGICAL AND PHYSICAL RESEARCH PROGRAMS

Question. NASA's programs in biological and physical research are crucial not only to accomplishing NASA's mission, but also to the health and well being of our citizens here on earth. Interdisciplinary research between the biological and physical sciences is particularly beneficial. Further, key collaborations between NASA, universities and research hospitals, such as the John Glenn Biomedical Engineering Consortium, can contribute immeasurably to NASA and the Nation. What are NASA's plans for continuing and enhancing these consortia?

Answer. The John Glenn Biomedical Engineering Consortium (BEC) was established in 2002, and currently carries out 10 research projects—each funded for 3 years—to address medical risk issues associated with human space flight that have been identified in the NASA Bioastronautics Critical Path Roadmap. The BEC is part of the Glenn Research Center's (GRC) new interdisciplinary program in Bioscience and Engineering that has been created to effectively leverage recent scientific and technological advances in the physical sciences and microgravity engineering disciplines. The consortium was designed to enhance NASA's progress in overcoming challenges in space biomedical research and to optimize the productivity of the space biotechnology program. Other components of the Bioscience and Engineering activity include interagency collaborations (National Eye Institute, National Cancer Institute, National Institute of Child Health and Development), Space Act agreements with the private sector in biomedical and biotechnology research, peer-reviewed research carried out by academic, private, and government institutions, and the NASA Bioscience and Engineering Institute (NBEI), which was recently selected through independent peer-review.

NASA's long range plan for the John Glenn BEC is to enable it to significantly contribute to the NASA's goals in Biomedical and Biotechnology research by establishing strong links to the extramural and intramural NASA research programs; by collaborations with other Federal agencies; and by partnering with the private sector. John Glenn BEC has pledged to achieve a self-sustaining status through funding from the above three sources.

It is the intention of NASA to continue supporting consortia such as the John Glenn BEC in the future. The agreements governing our relationships with such consortia contain sunset clauses that allow for competitive selection that motivate these entities to become self-supporting. NASA will continue to aggressively pursue commercial and academic entities as participants in technological collaborations that are compatible with NASA's Mission and Vision.

INNOVATIVE TECHNOLOGY TRANSFER PARTNERSHIPS (ITTP)

Question. Economic development is a national and regional priority. NASA's technology has been a strong contributor to the Nation's economic growth, and I believe will continue to be in the future. While the President's proposal changes NASA's Commercial Technology Program into Innovative Technology Transfer Partnerships, I am still concerned as to how the goal of getting NASA's technology into the marketplace will occur.

Answer. As described in the President's Fiscal Year 2004 Budget proposal for NASA, our primary emphasis would shift toward partnerships that engage the development of technologies directly beneficial to NASA missions. Under the proposed plan for Innovative Technology Transfer Partnerships (ITTP), NASA would continue to support the necessary efforts to document and license NASA technologies and make them available for use by the private sector. While the Agency would reduce the amount of active outreach activities to industry, we would conduct a reformulated technology transfer program that relies on the use of the eCommerce and web-

based systems to present information on technology that might be applicable for use by the private sector. The National Technology Transfer Center will continue to be one of the resources we use to transfer technology to the private sector.

COMMUNICATIONS, NAVIGATION AND SURVEILLANCE (CNS) SYSTEM

Question. A key concern is the National Airspace System and the need to incorporate advanced technology into that system through a cooperative effort between NASA and the FAA. In particular a transformed Communications, Navigation and Surveillance (CNS) system using advanced space communications technology is critical. What are NASA's plans for support of this CNS technology?

Answer. NASA has developed a research plan in communication, navigation, and surveillance (CNS) technologies, which focuses on space-based solutions to support the transformation of the National Airspace System (NAS) to meet future demands. The objective of this effort is to develop and evaluate critical CNS technologies, which will allow an integrated space-based digital airspace. In its fiscal year 2004 budget request, NASA has proposed to initiate this effort with the first objective being definition of CNS requirements and associated technologies for the future NAS.

NEXT GENERATION LAUNCH TECHNOLOGY PROGRAM

Question. I believe it is imperative for its future that NASA continue to develop advanced technology for future reusable launch vehicles to make them safer, more reliable and more cost effective. The Next Generation Launch Technology program is making significant progress in advancing critical technologies for NASA and other national needs in collaboration with the DOD. What are NASA's plans for this program?

Answer. The NGLT Program is a critical element of NASA's Integrated Space Transportation Plan (ISTP), which is comprised of the Shuttle Life Extension Program, the OSP Program and the NGLT Program. As NASA's advanced launch technology development program, NGLT will advance the state-of-the-art in critical and high-payoff technologies to enable low-cost, reliable, and safe future generations of fully and partially reusable launch vehicle systems. NGLT is oriented to support an Agency decision in 2004 on whether to proceed with a risk-reduction phase for a future NASA launch system that would be operational in the 2014–15 timeframe. All elements within NGLT seek to advance technologies that enable missions that are currently not technically or economically feasible. These missions include the exploration and development of space, enabling new commercial space markets, and enhancing the Nation's security. NGLT investments are not only enabling future launch systems, but also support potential upgrades to existing systems such as EELV and the Space Shuttle.

In cooperation with DOD, the NGLT program is a major contributor to two of three "pillars." The three pillars, High-Speed/Hypersonics, Space Access, and Space Technology, represent the building blocks in the integrated effort between NASA and DOD, the National Aerospace Initiative (NAI). In leading the Space Access pillar of the NAI, the NGLT will co-execute an integrated long-term national technology plan for Space Access Technology with the DOD. It is a priority to integrate the objectives of NASA and the USAF. The NLG's participation in this effort will serve to strengthen cross-agency relationships by addressing common needs and showing interdependencies with the High-speed Hypersonics Pillar, and identifying and mapping technologies to potential development programs.

QUESTION SUBMITTED BY SENATOR HERB KOHL

COMMERCIAL TECHNOLOGY AND COMMERCIAL SPACE PRODUCT DEVELOPMENT PROGRAMS

Question. I am concerned about NASA's decision to terminate funding for Commercial Technology and Commercial Space Product Development programs. The Commercial Technology Program has led to the creation of vital technology partnerships between government, industry, and the academic world and has promoted the commercialization of NASA research and development. The Commercial Space Centers (CSCs) have played a critical role in NASA's biotechnology research. The Wisconsin Center for Space Automation and Robotics, located at the University of Wisconsin-Madison, has spun-off three commercial companies and set up partnerships with many established businesses. Thanks to these programs, the first seed-to-seed plant growth experiment was successfully conducted during a recent International

Space Station mission with funding from a company located in Green Bay, Wisconsin.

If the American public is to reap the benefits of NASA innovation and expertise, successful technology transfer programs must continue. Given the clear benefits of CSCs, why have you decided to eliminate Commercial Technology and Commercial Space Product Development programs? How do you plan to maintain the exchange of biotechnology innovation among universities, private businesses, and government?

Answer. The fiscal year 2004 budget request for the Office of Biological and Physical Research (BPR) responds to the recommendations for research areas identified as high priority in the report by the Research Maximization and Prioritization (ReMAP) task force in 2002. As the ISS evolves from construction to continuous on-orbit research capability, the task force recommended that NASA prioritize the use of its unique, space-based research capability. To fully support the NASA vision, and in-line with these recommendations, BPR's new research strategy focuses on undertaking activities necessary to extend the human exploration of space. The NASA Advisory Council (NAC) and the Biological and Physical Research Advisory Committee (BPRAC) endorse this general strategy, as do the Research Partnership Center (RPC) Directors. In a limited budget environment, to accommodate funding increases in these programmatic areas, funding must be reduced elsewhere.

Just as the BPR fundamental and applied research programs are realigning with the BPR research strategy and the Agency's mission, the SPD program and the associated RPCs will also strategically reorient their goals to maximize the benefits of ISS research. Again, the RPC Directors support this realignment.

The current 15 RPCs are engaged in areas such as biotechnology, biomedicine, advanced materials processing, agribusiness, spacecraft technology and communications development. Where these also support the priority research in our Enterprise (and other Enterprises), the RPCs will continue to be supported. Some of the ongoing work is not aligned, so the fiscal year 2004 budget request proposes a reduction in the annual budget in RPCs from fiscal year 2003 levels, with the full reduction to be realized by fiscal year 2006. The proposed budget reductions will be completed only after a comprehensive and objective assessment of the present commercial research program, including feedback from an ongoing independent review of the RPC program, to be completed in fiscal year 2004. The RPC Center Directors are fully engaged in this process and will actively participate in the program restructuring. A recommendation regarding the refocused program, including updated budget projections, will be submitted with NASA's fiscal year 2005 budget proposal.

NASA will continue to facilitate the commercialization of space, and will focus on ensuring that commercial researchers have efficient access to space. NASA is seeking to provide more efficient means of access to the International Space Station (ISS) for all users. NASA's Integrated Space Transportation Plan (ISTP) is also being updated to address, among other things, assured cargo access.

CONCLUSION OF HEARINGS

Mr. O'KEEFE. Yes, sir, thank you, Senator.

Senator SHELBY. Thank you. The subcommittee is recessed.

[Whereupon, at 12:03 p.m., Thursday, May 1, the hearings were concluded, and the subcommittee was recessed, to reconvene subject to the call of the Chair.]