

**President's Commission on Implementation of United
States Space Exploration Policy**

**New York, New York
May 3-4, 2004**

PUBLIC MEETING MINUTES

Approved

A handwritten signature in black ink, appearing to read "Steven G. Schmidt".

**Steven G. Schmidt
Executive Director**

Approved

A handwritten signature in black ink, appearing to read "E.C. Aldridge, Jr." with a large flourish at the end.

**The Honorable E.C. "Pete" Aldridge, Jr.
Chairman**

President's Commission on Implementation of United States Space Exploration Policy
The Asia Society
New York, New York
May 3-4, 2004

Monday, May 3

Welcome and Introductions

Mr. Pete Aldridge, Chairman of the President's Commission on Implementation of U.S. Space Exploration Policy, welcomed attendees to the Commission's fifth and final Public Hearing. The Commission has heard testimony from a broad range of experts and the public. There have been four previous hearings—in Washington, DC; Dayton, Ohio; Atlanta, Georgia; and San Francisco, California. Mr. Aldridge introduced his fellow Commissioners:

- Ms. Carly Fiorina serves as chairwoman and chief executive officer of Hewlett Packard, which she joined in July 1999. Her roots are deep in technology and she served in senior executive leadership positions at AT&T and Lucent Technologies.
- Mr. Michael Jackson is senior vice president for AECOM Technology Corporation. He is the former U.S. Department of Transportation Deputy Secretary and was instrumental in the early formation of the Transportation Safety Agency.
- Dr. Laurie Leshin is the Director of the Arizona State University's Center for Meteorite Studies and the Dee and John Whiteman Dean Distinguished Professor of Geological Sciences at the University of Arizona. She uses cutting edge laboratory and spacecraft instruments to study the history of water in our solar system and possibility of life elsewhere.
- General Lester Lyles was in the U.S. Air Force for more than 35 years, rising from the Air Force ROTC program to become a 4-star general, and commander of the Air Force Materiel Command. In that pre-retirement position, he was responsible for the U.S. Air Force research and development community.
- Dr. Paul Spudis is a planetary scientist at the Johns Hopkins University Applied Physics Laboratory outside of Baltimore, Maryland. His specialty is the geology of the moon. He has studied the geology of Mars, Mercury, and many other worlds.
- Dr. Neil deGrasse Tyson is an astrophysicist and the Frederick P. Rose Director of the Hayden Planetarium in New York City. He recently served on the President's Aerospace Commission. He recently served on the President's Aerospace Commission which made recommendations to Congress and related government agencies on how to improve the health and future of this industry in the interest of the American economy and National Security.

- The Honorable Robert Walker is the chairman and chief executive officer of The Wexler & Walker Public Policy Associates, a firm specializing in telecommunications and technology issues. He served in the United States Congress from 1977 to 1997, representing his home state of Pennsylvania. While in Congress he served as the Chairman of the House Science and Technology Committee, with NASA oversight. He too served on the recent Aerospace Commission as its chairman.
- Dr. Maria Zuber is the E. A. Griswold Professor of Geophysics and Planetary Sciences at the Massachusetts Institute of Technology and leads the Department of Earth, Atmospheric and Planetary Sciences. Dr. Zuber has been involved in more than half a dozen NASA planetary missions aimed at mapping the moon, Mars, Mercury, and several asteroids.
- Mr. Steven Schmidt is the Executive Director of the Commission, the Special Assistant to the NASA Administrator, and the designated federal official for this Presidential advisory committee.

Mr. Aldridge reviewed the process of the Commission. It has been appointed by the President to make recommendations on how to implement the space vision (referred to as the Vision), which he set out on January 14, 2004. The Commission has been given firm direction, and its job is to recommend the most important strategies to accomplish the Vision. It will be a sustained journey, spanning many presidential terms. The Commission will draw on its expertise, as well as listen to experts and the public, to generate this plan. Perhaps 10 strategies will be selected to lead us to the Moon and Mars. Through its website—www.moontomars.org—it will be accepting comments from people around the world. This hearing is the first to focus on the building of international partnerships in space.

Mr. Aldridge introduced the first panel on “International Space Partnerships”: Mr. Daniel Sacotte, Director for Space Exploration, European Space Agency (ESA); Mr. Kiyoshi Higuchi, Executive Director of the Japan Aerospace Exploration Agency (JAXA); and M. Philippe Berterottiere, Senior Vice President of Sales, Marketing, and Customer Programs, Arianespace.

Mr. Sacotte’s testimony focused on four points: (1) a brief description of ESA; (2) ESA’s ongoing and planned activities in space exploration; (3) international cooperation at ESA; and (4) the European vision of international space exploration. ESA is an international intergovernmental organization composed of 15 member states. The primary focus of ESA is space research and development. ESA’s ongoing and planned activities in space exploration include: Mars Express; the Small Mission for Advanced Research in Technology (SMART)–1, a lunar probe; Rosetta; Cassini/Huygens (an ESA/NASA collaboration); Venus Express; BepiColombo; XMM-Newton; Integral; Herschel telescope; COROT; and Gaia. ESA is a key partner on the International Space Station (ISS) and has committed about 5.2 billion euros for its contribution. ESA is also contributing to ISS via the flight of the Automated Transfer Vehicle (ATV), a cargo vehicle to carry key ISS cargo and supplies. Europe is also contributing other elements, equipment, and design skills. ESA has had very

close cooperation with NASA over the past decades, and is currently collaborating with NASA on the Mars Exploration Program. ESA, NASA, and other international partners are performing detailed investigations of solar phenomena. In January, ESA established the Space Exploration Policy Assessment Group (SEPAG). ESA believes that space exploration is a global undertaking. Europe is already actively engaged in exploration and expects to play an essential role in the context of a global effort. The contribution of Europe must be affordable. Europe will strive to establish a program able to adjust to partners' calendars and variations. ESA plans to have a programmatic decision for the 2006-2010 timeframe about a year from now. During this first phase, Europe is expected to cover robotic missions, exploration technologies, and scientific support.

Mr. Higuchi shared his perspective on the President's vision. The vision is very attractive and challenging. JAXA is currently conducting plans for unmanned lunar exploration and is very interested in how the Vision will evolve. Space is a common heritage of mankind and is international in nature. JAXA has numerous cooperation projects with the U.S. in space science, Earth observation, and space environment utilization. The ISS is a new type of international cooperation in terms of content and scale. Many difficulties have occurred, such as numerous program changes, and the international partners have worked hard to overcome these problems with mutual understanding and cooperation. JAXA has accumulated precious experience in many areas. The ISS international partners must continue to cooperate so that the ISS can be completed and operated in a mutually acceptable way. JAXA is interested in how the U.S. Vision will evolve. A plan that is aligned with Japan's space policy and which brings mutual benefits would be an opportunity for cooperation. JAXA would like to see the detailed plan to be developed and would consider areas in which JAXA could participate.

Mr. Berterottiere shared the capabilities and experience of Arianespace. He provided a brief overview of Arianespace, the world's first commercial launch services provider. It has had a long-standing relationship with the U.S. commercial market. Europe is committed to optimizing resources to address all market segments, and has chosen to operate three vehicles: the heavy lift Ariane 5; the medium lift Soyuz; and the light Vega. The workhorse is the Ariane 5. It currently launches in two configurations for service to low Earth orbit (LEO), geo-transfer orbit, and lunar orbits. The company is currently evaluating a more powerful upper stage and has studied alternative configurations to create a super-heavy version if the need arises. All launches are from Europe's spaceport in Kourou, French Guiana. Mr. Berterottiere described Arianespace's capabilities. The current plan for the Soyuz in Guiana does not include human space flight, but the plan does not preclude it. There is an ongoing ESA study to ensure that the new facilities will be designed such that human space flight could be added in the future. Upgrading these facilities for human space flight could be an alternative for filling the gap between the Shuttle and the Crew Exploration Vehicle (CEV) in servicing the ISS. Arianespace has a history of success in launching complicated science missions along the lines of those that could be precursors to human exploration beyond the Moon. The company is committed to providing outstanding service to the science community as well as the commercial world. Mr. Berterottiere noted the innovative launch services alliance that Arianespace formed with Boeing and Mitsubishi in 2003. The partners are working together to provide missions assurance to commercial

customers using the Ariane 5, the H-IIA, and the Zenit 3SL vehicles. The program works like an airline code share agreement. Each firm still competes for contracts. Once the primary vehicle is chosen, the customer can also choose to add the mission assurance clause, activating the alliance systems that provide a launch opportunity if a problem occurs with the primary vehicle. The Commission should actively consider the capabilities of European companies and their ability to partner with US firms to achieve exploration goals.

Mr. Aldridge noted that it is clear that the development of the architecture must take into account international participation early in the process. Have there been any discussions on what role international organizations may play in development of the architecture?

Mr. Sacotte stated that the approach in Europe is the same as in the US—building blocks. For the moment, ESA has been discussing participating in some of the building blocks, e.g., the ISS. For the architecture itself, ESA needs to look at the requirements for the blocks. Architecture will be a key subject, starting this summer. ESA would like to have an open discussion with NASA. Mr. Higuchi indicated that JAXA is very interested in the US vision. However, JAXA has not started considering any specific way of cooperating on the architecture. JAXA does have its own unmanned lunar exploration program. JAXA is keeping a close eye on NASA and is very interested on how the U.S. vision will be translated into real plans. Mr. Berterottiere stated that Arianespace has not discussed with NASA any scheme for the Vision. The company is exploring with Boeing how it could set up collaboration, e.g., what we should do to provide adequate access to space for the Vision. The original Ariane 5 was planned to be human rated. That was stopped when Europe started the MS plane and more constraints were put on Ariane to make it an affordable launch vehicle.

In response to a question from Gen. Lyles regarding Evolved Expendable Launch Vehicle (EELV) participation, Mr. Berterottiere stated that the Alliance provides back-up services. Each company competes. There is no plan to segment the market. Through this alliance, we can provide a guarantee of launch on time. The adaptability of the ATV to an Expendable Launch Vehicle (ELV) family has been discussed and is doable. In response to a question from Dr. Spudis, Mr. Berterottiere indicated that currently, there are no plans to develop vehicles larger than Ariane V; however, there is a plan to develop a new upper stage to Ariane V that could improve its capabilities.

Dr. Tyson asked about the budget for ESA and JAXA and whether collaboration on the Vision would be a part of it. Mr. Sacotte noted that the ESA budget is distributed by the 15 member states. The member states participate following their gross product. The budget plan is discussed every 5 years. The content is the result of political willingness and industry participation. Next year, there will be decisions in three areas: Earth observations; telecommunications; and exploration. Exploration will be one of the three programs to start. The level will be about the same as the decreasing of the level on ISS. Mr. Higuchi stated that JAXA has an annual budget of about 180 billion yen (\$1.6 billion). Right now, about a quarter of this is earmarked for ISS. Mr. Higuchi explained how a budget is set in Japan. The Council for Science and Technology Policy sets forth that policy and makes the plans. In accordance with this policy, JAXA comes up with the long-term space development plans. In accordance with the policy, the long-term plan is reviewed from time to time. If the

Council finds that it is worthwhile to start a new program, a budget is allocated for that. If JAXA were to participate in the U.S. initiative, Mr. Higuchi indicated that he could not say at this moment whether the budget would be increased for that. The Japanese government has been suffering huge fiscal deficits and budgets are in a difficult situation.

Mr. Walker noted that the panelists hinted at capabilities that they could bring to the space business. He asked them if there were some special capability that the Commission should include as part of its thinking as it makes recommendations. Mr. Sacotte noted that Europe can bring the competencies associated with science and the ISS. Europe would be able to bring very important building blocks in implementing the vision. ESA is an international organization. Once a decision is taken, the value of the decision is very high, much like an intergovernmental agreement. ESA is probably the most reliable partner in the world. In addition, ESA has a fantastic network of cooperation. Part of the program will be industry to industry. Part of the program will be science-oriented, and will be scientist to scientist. What ESA can bring is a flavor of diversity and experience with cooperation with many partners. ESA can help with the mechanism of cooperation. Mr. Higuchi commented that he did not know the details of the Vision, and because JAXA has not made a formal decision, it is difficult to answer in terms of the technology area. However, in general, the feeling is that Japan has the capabilities in all the areas except for human transport to space. Japan has already launched a satellite to rendezvous and dock on an asteroid and take samples back to Earth. The SELenological and ENgineering Explorer (SELENE) mission will sample the lunar surface rocks. Japan has H-IIA and HTV capability for sending supplies to the ISS. In addition, Japanese industry has great potential for contribution using their state of the art technologies.

Mr. Aldridge thanked the panelists for their testimony. He introduced the next panel, "Lunar and Other Space Science": Dr. Tony Tether, Director of the Defense Advanced Research Projects Agency (DARPA); Dr. John Delano, Professor, Department of Earth and Atmospheric Sciences and Department of Chemistry, University at Albany (State University of New York); and Dr. Ariel Anbar, biochemist and Associate Professor in the Department of Earth and Environmental Sciences, University of Rochester.

Dr. Tether discussed DARPA and its projects. He noted that DARPA research efforts related to the Vision include: positional location in space; advanced communication protocols; extremely large deployable antennas; and long endurance space flight. DARPA has looked at using pulsars as sources in space (or anywhere) similar to the way that the global positioning satellite (GPS) is used for Earth positioning.

Dr. Delano provided a sense of the important scientific questions that could be addressed by the President's Vision. The Moon has preserved a rich, accessible, long-duration, geochemical memory, including the first 600 million years of the solar system. The Moon preserves a memory of the impact flux since the rise of complex life on Earth. The Moon may also include pieces of other planets that can serve as "Rosetta stones" for planets throughout our solar system. Dr. Delano discussed the historical perspectives on extraterrestrial life. The question is very important and historically durable. It seems likely that children from 20 years forward in time and beyond will look up at the sky much

differently than we do. American astronauts deserve epic programs that are worthy of their skill and courage and that will be historically durable. The epic journeys proposed under the initiative could become a lasting source of inspiration for future generations.

Dr. Anbar, a biogeochemist, shared his perspective with the Commission. He pointed out that a return to the Moon could help answer fundamental science questions beyond lunar science. Astrobiology is also a quest to understand how habitable planets formed. The challenge of the geologic record takes us to the Moon. To understand the origins of life, we need to study a much older part of the geologic record, and these records are poorly preserved on Earth. Early bombardment had a profound effect on the origins of life. Most of our knowledge comes from studying the Moon where the ancient record is preserved. Astrobiologists see lunar exploration as more than a stepping-stone on the way to Mars. We should return to the Moon with the intent of taking some of these compelling scientific questions with us. This should not detract from the human exploration.

In response to a question from Mr. Aldridge on why NASA doesn't have a DARPA-like organization, Dr. Tether noted that DARPA was formed in response to the launch of Sputnik. Both NASA and the National Reconnaissance Office (NRO) roots were offspring of DARPA. One thing that makes DARPA different is that the people are there for only a short time—4 to 6 years. There are no “careers.” People come from other places and go to other places. The Program Managers are different—they are people who have an idea and want to get something done. Even though DARPA has a long-term/high payoff perspective, they have a reputation of getting things done quickly. In order to have an organization like DARPA, the first thing to do is ensure that no one is there more than 4 to 6 years. This fluid workforce allows changes to occur.

Dr. Tyson noted that there are concerns that NASA is risk averse. In contrast, DARPA engages in projects where half of them fail. One of the concerns is NASA's tendency to only do that which is tested for 10 or 20 years, but this greatly limits how far you can get. Dr. Tyson posed the question: Would it be a culture change within NASA or the public to recognize the need for something like DARPA? Dr. Tether observed that even within the Department of Defense (DoD), the science and technology organization is very risk averse. It gets down to career. You have to be someplace where there isn't a career attached to success and failure. He opined that this probably couldn't be done within any existing organization today. In response to a question from Gen. Lyles on whether DARPA could look at some things that could be applicable to the Exploration Vision (other than those already noted), Dr. Tether indicated that it would take somebody above him to open that aperture. He admitted that there might be projects other than those that he noted that could have a dual purpose. In response to a question from Dr. Spudis, Dr. Tether indicated that DARPA is part of the DoD and would not take an interest in going to the Moon. The services are focused on the mission that they have—protecting the national security of the country.

Dr. Spudis asked Dr. Delano to comment on the regolith of the Moon. Dr. Delano stated that the clearest record is in the last 2 or 3 billion years. In terms of better understanding of bombardment history, the record is clear and waiting for us to explore. Dr. Anbar agreed.

The “Astrobiology and the Moon” white paper has laid that out as another topic. We would want a multi-layered approach—some things from orbit, and some things from the ground, e.g., coring, trenching, samples. Dr. Delano added that one of the most common materials is impact-produced spherical glass, which as a memory of the impact event.

Dr. Zuber noted that in the future, there are two paths for sample analysis—in situ technology development versus the technology required to bring samples back to Earth. In terms of the big questions, what is the more productive path? Dr. Delano stated that the big questions will be answered by the best analysis; the only way to do that in a reasonable time is robotic sample return. Dr. Anbar indicated that he would agree with most of that. The time scales depend on the technology available to do things in situ. The best work would still be here on Earth, but you may be able to do excellent work in situ 50 years from now.

Dr. Leshin posed questions for the educators: With the announcement of the Vision, are you getting any reaction from students? Do they see possibility? Dr. Delano noted that at most of his talks (on astrobiology as related to geochemistry), he has as one of his goals to be in the epiphany business—to light the wick and see the sparkle. It does not happen all the time, but it happens more than half the time. At most of his talks, he has been getting many requests about the topic. Dr. Anbar observed that there has been excitement and interest from students outside of the traditional science majors. At the same time, in terms of the Vision specifically, there is a bit of hesitation—a questioning of what it is, as well as some cynicism. The challenge is how to combat the cynicism and engage in the exciting science questions. Dr. Tether added that what NASA seems to forget is that during Apollo, everyone wanted to go; somehow, we lost that. Until we get that excitement back, nothing much is going to change. We need to figure out a way that isn’t exclusive—so everyone will “get to go.”

After a short break, Mr. Aldridge introduced the panelists for “Space to the People!” Mr. George Whitesides, Executive Director of the National Space Society; Mr. Nick Eftimiades, founder of the Federation of Galaxy Explorers; Mr. Frederick Hauck, former astronaut representing the Association of Space Explorers; and Dr. Louis Friedman, Executive Director of The Planetary Society.

Mr. Whitesides noted that “Space to the People” is a perceptive title to bring to the conversation on the Vision. The American public will determine the ultimate success of the vision if you can establish an individual connection to them. The most crucial question facing us is: How can we shape the initiative to engender sustained and robust public support for space exploration? The National Space Society strongly supports the Vision. Mr. Whitesides stressed several key points. First, we must do real exploration with real heroes taking real risks, and we must engage the public. The public does not want us to risk less; they want us to risk more—for worthy goals. Second, we must build the private sector. This is the deepest form of public engagement. The degree to which the initiative stimulates private enterprise throughout the solar system will be in the indicator of success. The initiative must build infrastructure that industry can use. Third, we must involve the public in the near term, mid-term and far term. Fourth, we must evangelize an exploration society predicated on re-settlement—society settling beyond Earth. Without it, exploration is a dead

end. We must advance our ability to work and live successfully in space. This must include settlement. Exploration is a noble goal and is worthy of society's support. It is critical that the U.S. continue exploring and that this vision blossom into a rich and growing reality.

Mr. Eftimiades discussed the Federation of Galaxy Explorers (an organization about 22 months old), and how the organization fits into the Vision. The Federation started with a summer space camp for kids in Prince Williams County, Virginia. It is focused on inspiration as well as education. The program has developed lesson plans and put over 2000 kids through the camp, all done by volunteers (about 300) that work passionately for the cause. Mr. Eftimiades shared his thoughts on "mass movements." A key challenge for this Commission is to capitalize on the vision of hope for the future. Look at expanding our society into the solar system. We need to foster this and push it forward. The spending will be driven by the will of the people, and they need to be inspired by the hope for the future. The Federation of Galaxy Explorers deals on a grass roots level. The one unifying factor of people that are not in the space community is that they recognize how much this means for their kids and the future. "Hope for the future" should be a focal point of the vision.

Mr. Hauck stated that the Association of Space Explorers, composed of men and women who have flown in space, strongly supports the view that exploration is an investment in our country's future. The members applaud the President's commitment to a long-term human and robotic exploration program. One common thread of the members is the belief and the importance of every-expanding exploration, and the willingness of people to risk their lives in pursuit of that imperative. Mr. Hauck noted that an overriding consideration in his taking risk is his confidence that everything reasonably possible had been done to minimize the likelihood of failure. The government should provide incentives to entrepreneurs and venture capitalists that are willing to take some of the financial risks. The X-Prize and Centennial Challenges are welcome steps. There are a number of educational programs that merit recognition and support. The Vision excites imagination and points the way to a goal that humans have dreamed about and fantasized about for decades—the human exploration of Mars.

Dr. Friedman noted the he was representing The Planetary Society, a public interest group and the largest membership-based space-interest group. It is deeply involved in many aspects of the program. Dr. Friedman testified on three main topics of the hearing: public interest, international cooperation, and lunar missions. The new policy calls for international cooperation in space exploration, and the Planetary Society supports that. Unfortunately, there are strong US Government restrictions imposed on international cooperation, most notably the ones preventing the use of the world's over-supply of launch vehicles. The Planetary Society has some specific ideas for advancing the exploration programs, specifically Mars Outposts—a place on Mars that will be explored. An interim goal has been what to do on the Moon. The Society has expressed a great deal of skepticism about the lunar piece because of the danger in a "lunar detour," but there are significant things that could be done on the Moon, e.g., a lunar way station to prepare for doing things on the surface of Mars. Exploration of the Moon is of international interest and we should harness that energy to move the initiative forward. Dr. Friedman observed that the Administration's central attitude is a change to exploration: it is a vision and focus beyond low Earth orbit; it

commits to the retirement of the Shuttle; it has a willingness to accept a gap and launch on foreign vehicles; it has a redirection of the goal of the ISS; it puts Mars forward as a goal; it is responsive to the public interest in exploration and has strong support for science and the robotic-human mix; and it has international cooperation. The concern is that there are many people who want to pick and choose among these aspects, and the Vision could die a death from a thousand cuts. The Vision has to engage the public.

In response to a question from Mr. Aldridge regarding risk and fatalities of “extreme adventures” like climbing Mt. Everest, Mr. Hauck commented that people who are in the business of the high end of adventure travel have told him that they have to assure their customers of a less than 1 percent chance of fatality; however, ascending Mt. Everest claims a higher percentage than this.

Dr. Tyson commented that the membership roles in the National Space Society and the Planetary Society are not what they once were; however, there is a grass roots interest. What should be our measures of actual interest of the public when we have conflicting information? Mr. Whitesides noted that there is interest in space. Space.com’s numbers of visitors increase by 50 percent per year. What people yearn for is to be directly involved. The Federation of Galaxy Explorers offers the opportunity to be directly involved. If we create opportunities for adults to be directly involved, then they will. The decline in public space advocacy numbers is basically a function of that. We have moved to a phase where people want to have more direct involvement. Mr. Eftimiades agreed. The issue is engaging people and getting them involved. The interest is there; the challenge is galvanizing it and organizing it. We must find the mechanisms to engage them and bring them into the adventure. Dr. Friedman stated that he didn’t completely agree that any of these would necessarily boost the membership in the space organizations. We must be careful about the metrics we use to measure interest in space. Many activities will measure the public interest—it is the total milieu that we must take into account.

Dr. Spudis observed that it is one thing to engage the public, but the challenge is translating public support into political muscle. It is an issue of getting the Congress behind us. Given that we can engage the public, how do we translate that support into political action?

Dr. Friedman indicated that the Planetary Society has been rather successful, e.g., the Pluto mission, the Mars budget. There is evidence that public support does make a difference in Congress. However, the average Congressperson thinks they are ahead of the public. We have to keep at it. Mr. Hauck stated that we need to encourage the enthusiasm by pressing the question—encourage people to write their Congressperson. Engaging the Congress is critical. Mr. Whitesides added that a constituency of people is the crux of the issue. One of the biggest challenges is moving from a group of enthusiasts to a constituency of people. Mr. Eftimiades felt that it is an issue of organization. We need to have a mass number of people with one unified thought and one course of action, and with select activities on the Hill. Dr. Friedman commented that we really have a vibrant program of exploration—we are exploring Mars at every opportunity; we have missions to Saturn, Pluto, and the Kuiper belt. It is a rich time for exploration. Until now, the human program has not had that view, and we do now. In response to a question from Dr. Leshin regarding what NASA could help enable, Mr. Eftimiades indicated that NASA should lay out both a long-term strategic plan and a

short-term plan. It should identify stakeholder groups; lay out government agencies, industry, academia, and Congressional activities; develop milestone to accomplish every year, etc. Mr. Whitesides added that the Planetary Society and other groups will be coordinating an effort that will be announced on Friday. It would be useful for NASA to be open to a wide range of outreach ideas. It is important to support them in continuing to think outside the box in terms of who they can partner with, e.g., interesting sub-groups and unconventional partners.

Ms. Fiorina noted that it is important to galvanize public support and extend it to a grass roots effort as well as a government effort. She noted that the public does not tolerance incompetence or dishonesty, but will tolerate risk. Therefore, we should be open and honest about what the risks are. Mr. Hauck agreed. If you don't fail, you are not trying enough new things. We should be clear that we will lose more people, but it shouldn't be because of incompetence or not doing the right thing. Dr. Friedman also agreed also from the robotic side of the program. For example, the risk inherent in the airbag landing was part of the drama. The second example will be in the area of nuclear power in space. NASA needs to be honest and open about this.

Mr. Walker noted that many group organize well to have meetings and put together newsletters, but have not done a very good job of organizing politically. Nobody feels like they face any political heat for opposing what goes on at NASA. The American Association of Retired Persons (AARP) and the veterans groups are better organized. He asked the panelists if the groups they represent would commit to organize politically. Mr. Whitesides agreed that there is a great opportunity to task us on this issue, and his answer is yes. We need to use new technology in activating people and mobilize the troops. Dr. Friedman observed that space doesn't touch people the way that health, gun control, social security, etc., touch people's daily lives. These groups get better representation. He indicated that he supports all the points Mr. Walker made, but the job is broader—it has to be brought into all elements of society. Mr. Walker commented that right now, things are so close that a few people in the House and Senate can change the outcome of the NASA budget. Mr. Eftimiades stated that he would be willing bring a dozen people to the table to make that happen.

Mr. Aldridge adjourned the session at 4:00 p.m.

Tuesday, May 04

Mr. Aldridge noted that at the end of today's session, the Commission would have a deliberation session that would be open to the public, and members of the audience were invited to attend.

Mr. Aldridge reviewed the purpose of the Commission, the chronology of events to date, and the process that the Commission is following to meet its chartered task. After introducing the Commissioners, he introduced the first speaker on the topic "Sustainability and Management," Mr. Roger Krone, Senior Vice President of Army Systems for Boeing Integrated Defense Systems.

Mr. Krone testified on the Future Combat Systems (FCS) Program. Transformational activities are occurring within the Army. FCS is a network centric, systems-of-systems approach to land combat. It is a new way to sustain the fight. It also changes the way that the Army deals with technology and the fundamental way the Army does business in procuring its weapon systems. The FCS provides an integrated unit of action. Incentive fee is tied to completion of milestones. The fee structure was designed for alignment between the contractor and the government customer. The contractor is motivated to provide the maximum satisfaction to the Army. Mr. Krone described the network centric architecture. All information is made available on a tactical Internet and everyone can access information and data for situation awareness. The system-of-systems is optimized around eight key performance parameters. Mr. Krone discussed how the program is run. Setting the program up correctly in the beginning goes a long way to achieving success, and this was accomplished. Cost estimates are built jointly with the customer, and they are understood by all parties. There were numerous independent reviews. The program used the Lead System Integrator (LSI) approach. Mr. Krone discussed how this is different from the prime/subcontractor approach. The LSI is a "general contractor," doing the trade studies and integration. The LSI focuses on systems engineering, systems integration, and systems planning and control to provide a "system of systems." The LSI gets the best systems the industry provides, acting in a commercial fashion to put together the team. Smaller, entrepreneurial companies can be brought easily into the program. Mr. Krone highlighted the key aspects: start out with a good baseline; execute through a series of management plans, continuing with independent reviews; have weekly earned value reviews; make corrective actions; and have rigid change management to cost, schedule, and technical elements. Mr. Krone discussed systems engineering. The core is a single, integrated, open architecture. All team members have bought into the open architecture, which is similar to a commercial information technology (IT) architecture. Mr. Krone described the horizontal and vertical integration of the work scope, which is unique to this program. He discussed how requirements are dealt with in a system of systems. Mr. Krone summarized the important aspects of his testimony: an executable program from day one, including funding stability; management of the system-of-systems engineering process (the LSI); a robust requirements process; and getting the right team together with shared values and vision.

Mr. Aldridge noted that there is a similarity between the FCS program and the Vision. In response to a question from Gen. Lyles regarding key lessons learned, Mr. Krone shared some observations about what worked and what didn't. The program was successful because of some key, top-level officers that provided leadership in getting the "stove-piped" organizations to work together. Other important aspects were: absolute alignment at the senior level around a common goal; communication with all the stakeholders; the ability to create a collaborative environment among DARPA, the Army, and industry; and open communication of trades, status, etc., done within an environment that does modeling and simulation to check against achieving the goal.

In response to a question from Dr. Zuber regarding the process for setting milestones and metrics of success, Mr. Krone indicated that Boeing sat down with the Army and defined what the team was trying to achieve, and a high degree of trust was created. After achieving

this level of trust, the team together decided what the milestones should be to best achieve the goal. With respect to the incentive part, the team selected five interim milestones, tied to events. The customer determines whether the contractor receives the fee. The base fee (10%) is large enough to keep the contractor focused, and takes the contractor out of negotiation and gamesmanship to achieve the fee.

Mr. Jackson observed that in the Vision, the Commission sees a theme of building a space industry, not just a space program. To structure the role of the private sector, there is a more complex matrix. The integrator role would look to both the government's interests as well as those in the private sector. He asked Mr. Krone to talk about how the lessons learned could be stretched to this different type of challenge. Mr. Krone indicated that Boeing also manages the government furnished equipment (GFE), so the LSI role extends beyond executing the contract. However, Boeing has not been asked to maintain the industrial base for the Army. He admitted that he didn't know how well an LSI could deal with maintaining an industrial base unless the premise is founded in good business. Companies in innovation work well when there are appropriate incentives. You will get innovation if the appropriate incentives are there for risk and return. If the LSI tries to over-manage, it may create structural inefficiencies and preserve companies that shouldn't be preserved while stifling innovative, new entities. You would need to create a structure that allows for both the Boeings and the small innovative companies that can see a reasonable return on investment. This will be a challenge.

Mr. Aldridge introduced the next panel, "Astrophysics for the Beyond": Dr. Catherine Pilachowski, President of the American Astronomical Society (AAS); Dr. William Smith, President of the Association of Universities for Research in Astronomy (AURA); and Dr. David Spergel, Professor in the Department of Astrophysical Science at Princeton University.

Dr. Pilachowski testified on behalf of the AAS. Scientific research is the most fundamental form of exploration. The President's Vision challenges us to think bigger about exploration of the universe. The Vision must transcend short-term goals. With the development of new space infrastructure, the opportunities for space research beckon. At the same time, we are challenged to maintain NASA's basic research to understand the connection between the Sun and the Earth. The National Research Council (NRC) report stressed the importance of the interplay between science and exploration and encouraged NASA to have a balanced program. Astronomical facilities are not the rationale for going to the Moon, but astronomy can benefit from a robust lunar and Mars exploration program. The AAS recommends that NASA's implementation plan call for an assessment of how best to take advantage of the new structure for science and exploration. Dr. Pilachowski noted that many young adults are not convinced that space exploration is relevant to their lives and the solutions to problems on Earth. To engage the public over the long haul, NASA needs to articulate the economic, social, technical, and intellectual value of space exploration. Part of the Vision is to search out planets and life on other solar systems. We will have the capability to send a probe to other stars, and the astronomical community stands ready to make the President's Vision a reality.

Dr. Smith presented a statement on behalf of AURA. One of the long-term goals of AURA resonates very strongly with conducting advanced telescope searches for other planets and life around other stars. Dr. Smith summarized the major outcomes of AURA's discussions. He also noted the NRC report for a high quality and productive program. There has been discussion regarding building major observatories on the Moon. This requires further study. The discussion within AURA is that on balance, there are probably more disadvantages to this than advantages, partly because the advantages of conducting observations in low Earth orbit and deep space have been proven conclusively. However, Lagrangian points are emerging as very desirable as well. A major opportunity is offered for the development of a robust robotics program that can service telescopes in low Earth orbit and deep space; however, it is not clear whether the in-space robotics aspect is a major feature of the Vision. This could have synergy for surface rovers. AURA is already beginning to see robotic servicing as something that should be pursued, e.g., the proposed robotic servicing of the Hubble telescope. This investment is large, but could be made more valuable if placed within the Vision's larger context. One source of discomfort in the community is that the Vision articulated thus far has not really involved the scientific community in the planning process. There should be consideration of a better way to engage the scientific community in this process.

Dr. Spergel discussed the implications of the Vision for astrophysics. The search for extra solar planets excites both scientists and the public. NASA is already engaged in a long-term program for detecting Earth-like planets, and a series of missions are now underway. The results will stir the public. In addition, we will have the opportunity to characterize these planets. There has been remarkable progress in developing technology to detect Earth-like planets and signs of life beyond the solar system. Dr. Spergel noted the two Terrestrial Planet Finder (TPF) missions. The combination of these telescopes will be particularly powerful. TPF is an interesting model for the exploration initiative. NASA selected four teams to develop novel ideas and suggest new designs and new approaches. Using this approach, NASA will be able to achieve its planet characterization goals at lower cost and more rapidly. A future Life Finder mission will be able to detect life itself, but require investment in several new technologies. These long-term programs are an essential part of the "and Beyond" element of the Vision. One of the negative aspects of the Vision has been the delay in the Beyond Einstein program. There will be a loss of exciting science opportunities, national leadership, and public support if NASA abandons its approach of supporting the highest rated science programs. Another disappointment was NASA's failure to maintain the budget level of the Explorer Program. Although the new exploration initiative provides important direction, Dr. Spergel stated that it is important to maintain a diverse, space science program. The search of planets and life will be one of the jewels of the program.

Dr. Tyson asked about how we should do science and engineering in practice. While there are decadal surveys that prioritize science, should the Vision have a technology report every five years, laying down where it thinks the technology will go? Dr. Spergel commented that knowing what's possible helps the science questions, but the interplay should take place constantly. The exploration initiative should have an ongoing Federal Advisory Committee Act (FACA) committee that includes scientists, technologists, and engineers. The initiative

needs contributions from many communities. He advised care to avoid a top-down vision. We should allow ideas to bubble up as the technology advances.

Dr. Leshin raised several questions about the science goals and the planning process. How broad is the process? Is the community looking at getting aligned with the Vision and taking advantages of the capabilities? Where should the science planning process go from here? Mr. Smith stated that the NASA strategic planning process is important and far-reaching. NASA attempts to involve the broadest sections of the science community, and its planning process is a very successful way of taking disparate priorities and putting them together in a rational way. The process is in place; however, the process of the new Vision is out of sync with that. What must be recovered is the planning process. The community has always been bounded by the budget and can deal with that. People need to understand how the Vision can factor into planning and how technologies can play out. He urged NASA to give the process a chance to be successful.

With respect to engaging skeptical young people, Dr. Zuber observed that everyone has a role to play. The scientific societies should also speak about the importance of the space program to young people. Dr. Pilachowski commented that what students want to see is the importance of these investments to people on the planet. They want to see it happen, but they don't want to pay for it at the expense of other programs that help people and the planet. It is a broad societal issue—we need to help the public see the economic and societal value of the space program. It needs a broader message. Dr. Zuber stated that a large fraction of undergraduates take astronomy, and it is a good vehicle for reaching young adults and educating them on the economic and societal values of the Vision. The Vision needs more advocacy than NASA alone can provide. Everyone who believes in the Vision must do his or her part.

Mr. Walker observed that we have the National Science Foundation (NSF), where the budgets are expanding. Why do we assume that NASA's budget is the only place that we can do this good work? Dr. Spergel noted that there are things where space is the best environment. NASA has the expertise to put things in space. On the other hand, there will be an experiment in Chile where everything can be done from the ground, and we go to the NSF. The way the NSF's mission has been defined is that when things are done from space that is NASA's responsibility. Mr. Walker stated that there is no reason why that artificial wall has to be there. Those walls have been built over a period of years, and given the nature of science, no longer make any sense. Help us break down some of those walls rather than relying on a NASA budget. Dr. Smith agreed that the stovepipe syndrome is frustrating. There is a first step that has been put in place—the creation of an advisory committee that merges the apparatus of both NASA and NSF to look at this issue. The stovepipe approach doesn't serve science very well. Dr. Pilachowski added that NASA, NSF, and the Department of Energy (DoE) have come to the table to look at scientific questions, and from where the best contributions can come. The Office of Budget and Management (OMB) has issued a report outlining a process for this type of planning.

Mr. Aldridge posed the question: Why wouldn't we make detecting an Earth like planet a goal (e.g., by 2012) so that it happens by design? Dr. Spergel indicated that this is a realistic

goal. In that timeframe, we will be capable of detecting one, and setting a goal like this would be very helpful.

Mr. Aldridge noted that “Prosperity and Competitiveness” is one of the four major themes, and he introduced the panelists for this topic: Mr. John Higginbotham, founder SpaceVest; Mr. Joel Greenberg, President of Princeton Synergetics; and Dr. Myles Walton, a researcher at Morgan Stanley.

Mr. Higginbotham opened his testimony by laying a context for the space industry. He noted that it includes the public sector, commercial applications, and technology platforms. It is useful to reflect on the breadth of the industry. The technologies forecasted for this Vision represent very exciting technologies. On any measure, the economic benefits associated with this Vision justify the public investment. It is important to crystallize the nature of the benefits and communicate them clearly to the general public and the marketplace. That communication has been difficult in the past. Mr. Higginbotham suggested that one task should be to commission a comprehensive industry model that would utilize the capabilities of some leading research foundations to get a common perspective on the benefits to the public. From that, we could develop messages to the right audiences, backed up by a clear lexicon and using the media houses. In these messages, we need to address misperceptions and misconceptions, e.g., that the industry is only about government programs and launch vehicles. That will spill over to the capital markets. Capital markets have been supporting the industry, and decades of investment have gone into space-related businesses. We need to discuss what it takes to develop the framework for investors to invest in a sustainable way. In order to have a sustainable undertaking, some hard decisions need to be made—a national undertaking to organize for sustainable success. There is a cultural issue that needs to be examined. Industry has avoided innovation on many fronts. To embrace the entrepreneurial spirit, we need to reflect on the culture, think more “out of the box,” and look into new areas of skill centers. To execute this, we need to find and motivate the leadership. We need to change the game—target and develop the workforce, incentivize the system integrators, attract the innovators, etc. It is critically important to integrate the non-traditional skill centers on a programmatic level, not an ad hoc level. We must foster and use commercial capabilities, e.g., buy commercially for non-critical items. We have to create and capture the technology value. The skill sets necessary to turn a technology into a product and sell it to a customer are just as hard as the skill sets needed for going to the Moon or Mars. The skill sets are very different, and we need to access those non-traditional skill centers and integrate them up front in a programmatic way. This initiative has the opportunity to recapture the imagination of the public.

Mr. Greenberg presented his view on some cost and program planning considerations and potential benefits of the Vision. Princeton Synergetics, Inc., is a policy research and consulting firm with a broad client base. The Moon Mars mission requires a long-term, multi-phase research and development (R&D) program that continually “buys” information and adjusts plans accordingly. Planning requires the explicit and quantitative consideration of uncertainty and risk. We must plan for the fact that we may have failures along the way. We have to set guidelines for when to “turn off” an R&D program. Program planning has three interrelated degrees of freedom—cost, performance, and schedule. When there is

uncertainty, it is not possible to specify all three. One has to continually look at the information in each phase and adjust where we are going. High on the list of potential benefits is the pride resulting from success, but if we don't plan properly, we may end up with frustration. Also, the pride can be enhanced by reaching other goals, e.g., energy independence. There are job creation benefits from additional expenditures. Job creation, however, is short term and lasts as long as funding lasts. Technology development can lead to spin-offs and has long-term productivity impacts on the U.S. economy. Productivity gains are related to the R&D content of the program, not operations or infrastructure. Technology development and productivity gains can have significant impact. Unfortunately, one cannot say what specific multiplier is correct, because there is weak linkage between R&D programs and productivity gains and the gross national product (GNP). In the space industry, low cost transportation is of utmost importance. If not conducted properly, the Moon Mars mission may not satisfy the needs of industry. If the transportation part of the program could take into account commercial needs and low cost, that would be a significant impact on the commercial development of space. Mr. Greenberg also noted his concern with the impact on Hubble Space Telescope (HST) and other programs as well as the withdrawal of the US from the ISS program and the impact on the partners. Worldwide participation in the Moon Mars program is essential.

Dr. Walton spoke from the context of a Morgan Stanley analyst. Morgan Stanley has or intends to have relationships with the aerospace industries. The commercial space industry has had problems, and it is not isolated to a single contractor. The natural response of investors is one of skepticism. Investors are willing to pay for three things—predictability, visibility, and profitability. Business models in space are hard to predict. Visibility allows for a long-term horizon. Space has very interesting products, but that is not enough for the long term. With regard to commercial space endeavors, a completely healthy value stream has yet to materialize. There are a few niche, profitable ventures. It is becoming harder to convince investors that this is a good market. What elements of the Vision can be leveraged? Placing commercial endeavors on the critical path would be a mistake. Sometimes only national imperative is enough to push through the odds. Government should continue to take the lead. Space imagery is an example where there is a high value service. Another positive influence is the X-Prize, providing a proving ground for products and allowing for lessons learned. However, parallel work must go on at a national level. There are certain areas where commercial driven models do not make much sense, and space is one of those. Space travel is very much a public good, not a profitable commodity. Dr. Walton recommended insertion of policy “hooks” that open the door for future development of space. One example of this was GPS with a both a military and commercial band. Leave the door open; continue to encourage emerging space enterprises with regulatory relief.

In response to a question from Mr. Aldridge, Mr. Higginbotham noted that buying data services and launch services creates a market and start to address some of the issues. He had several recommendations. Rethink what the Agency should be doing. The operation of non-core activities could be spun out to the private sector. Find a way to embrace the educational requirements and off load some of those activities. Find out how to interface better with external communities, rather than starting up a new function inside the Agency. Look at the core mission, and spin out anything that doesn't relate to it. Dr. Walton observed that for

data services and launch services, the consumer is still the government. Mr. Greenberg agreed that there are costs to buying or using commercial sources. The cost will only be reduced if there is a demand from the commercial side.

Dr. Spudis posed several questions: How do you connect spin-off with a specific program? Is the problem really communication or is it analysis? Which is greater? He suggested that the analysis part might be harder, and Mr. Higginbotham agreed that it is. The study should be inclusive of analysis. Mr. Greenberg felt that analysis is not the problem. What is important is to have innovators that are interested in trying to develop something new. Successful spin-off is created by an Agency improving the awareness of what is new and what the technologies are, and having the innovator at the other end.

In response to a question from Mr. Walker regarding the size of the prize, Dr. Walton stated that the prize is at the end of the line, and the capital is needed to get there. The question is, will the effort have the longevity to endure failure? Encountering failure is natural, and it will be scary for investors. Mr. Higginbotham observed that from institutional investors, there will always be “angel” funds. For sustainable institutional investment, look for the business, not the “stunt.” The prizes will not attract institutional investment. However, if a vehicle is created whose services can be purchased, that would be a good investment. In response to a question from Dr. Tyson regarding opportunities for investment for activities far from Earth, Mr. Higginbotham commented that we are having trouble getting to LEO. In the short term, this initiative lays the groundwork for potential non-core activities to be outsourced. In the mid term, there is a potential for emerging technology. In the long term, we will have serious exploitation of Moon and Mars. Mr. Greenberg added that we shouldn’t worry about the long-term commercialization. If we are successful, new opportunities will open up. We should worry about the fall-out along the way—low cost transportation that can be used immediately and in the short term.

Mr. Aldridge introduced two more members of the international community: Dr. Marc Garneau, President of the Canadian Space Agency (CSA); and Dr. Volker Liebig, Program Director of the German Aerospace Center (DLR).

Dr. Garneau represented the Canadian government and the CSA. The Canadian space program is an example of a leveraged partnership. The legacy of collaboration and space ventures continues today. CSA champions the nation’s space priorities. CSA joined the ISS program and has contributed a specialized robotic system that is critical for assembly and maintenance. The primary objective of Canada is use of the unique laboratory in the microgravity environment. Participation in the ISS represented a major challenge. He shared the Canadian experience as an international partner. Canada has demonstrated its capability to act as a reliable partner. It is important to participate in international space projects, and CSA is developing a new long-term strategy for its space programs. An umbrella legal framework would allow participants to explore opportunities for partnership. The initiative should take into account national programs that are complementary. It could provide for a more robust program. National political considerations should not hinder program progress. Export control mechanisms should be established to facilitate free flow of information among partners. Dr. Garneau congratulated the Administration’s boldness in

setting a new vision for exploration of the solar systems. Canada intends to maintain its role as a reliable partner.

Dr. Liebig stated that the space communities appreciate the attention of the President on this vision. The European Union (EU) support will be broader. Europe is developing some momentum and this is the time to take on challenging tasks. The priorities of Europe include Earth observing systems, monitoring of the environment, and new communication systems. Germany is the largest net contributor to the EU and will support the new initiatives. The DLR has a 40-year history of cooperation with the U.S. He highlighted some of the successful collaborations. A number of German astronauts have flown on the U.S. Space Shuttle. Germany is among the prime contributors to the European space program. About 35 percent of Germany's space-related budget is spent on the ISS. Today, the Columbus module stands ready for launch. The German built Automated Transfer Vehicle (ATV) will be ready next year to supplement the Russian Progress for cargo delivery to ISS. Ground structures are getting ready for the utilization phase. To Germany, ISS is still the first step. Don't abandon this goal halfway. In 1998, ISS was a great vision, intended for an international crew of six and a steady exchange of experiments, support by adequate up and download. Retirement of the Shuttle in 2010 raises some questions. The X-38 approach was terminated in the US. While recognizing that ISS is a priority for Germany, Dr. Liebig commended the Moon Mars vision. He noted that Germany has a proud history of unmanned research, and many achievements have been reached with its US partner. The DLR and the German science community have participated in Mars Express and the Rosetta mission. Dr. Liebig noted the German expertise in materials, particularly in thermal protection systems. Germany claims a leadership position in various aspects of technology, such as laser communications. Space robotics is another area of interest. Germany is working with Canada and Japan in software development. Germany has been working on a second-generation life support system. This could be applicable for the exploration initiative. The focus of Germany and the EU is application program, but Germany is relying on the U.S. living up to its commitments on the ISS. Dr. Liebig congratulated the U.S. for providing the vision for the Moon Mars program.

Mr. Aldridge asked the panelists if they wanted give the Commission any advice on what to say on international cooperation. Dr. Garneau indicated that he could say that the international community would like to participate. At the same time, we must complete our engagement with respect to the ISS. We must learn some lessons from that experience. This is a long-term program. The one way to maintain public support is to show that the initiative is a serious scientific, technological, and human endeavor. The best way to achieve long-term support is to make it happen on schedule, within cost, and to achieve what we say we are going to do. Public support within Canada tends to wane when there are continuous schedule slips and overruns. Dr. Liebig agreed with Dr. Garneau. He stated that he strongly believe that to be successful, international participation is important. The mission should be done together. It is important to show reliability and continuity for the first step. Public support for space issues is tremendous in Germany. Political support is somewhat more difficult, and there are budget problems. He asked the Commission to please keep the possibility to cooperate open for a longer time period. There will be many worldwide partners.

Mr. Aldridge noted that two approaches for international participation are being discussed: elements done by nations, and nations bringing their components to fit into a larger piece, similar to the way the Joint Strike Fighter (JSF) was done. Are these two models consistent with how we might plan international participation in this initiative? Dr. Garneau stated that the first thing is to decide what we want to do. That will turn us toward one of the models. Bear in mind the partners' capabilities and objectives. Dr. Liebig noted that there is no contradiction between the two models. Both will co-exist. Even if Europe does some of the missions independently, there should be cooperation between the programs. This exists currently. We can imagine that there will be industry-to-industry direct cooperation, but a governmental umbrella is necessary.

In response to a question from Mr. Walker on whether Europe will increase the amount of funds that will be contributing to overall space efforts, Dr. Liebig noted that the DLR lobbies the German government to increase space spending. About \$5 billion is spent on the civil space side in Europe (\$3 billion by ESA). Dr. Liebig stated that he hopes additional funds will be available. It is possible that a readjustment of budget lines could free up some funds. Ms. Fiorina asked what the EU and Canada would do if the U.S. decides that the initiative isn't worth it and we will stay where we are. Dr. Liebig indicated that in the short term, Germany would concentrate on what it has already decided to do through 2013 and beyond. Mankind will not stop exploring the solar system, but it would take longer. Dr. Garneau agreed that exploration of the solar system is going to happen one way or the other; it is just a question of how long it takes. If the Mars missions go to the end of this decade, Canada would continue to work with the US. Canada would continue to look for partners to accomplish scientific exploration. If the U.S. gets off the venture, it would take a lot longer, but there is sufficient mobilization across space agencies that it will happen eventually.

Dr. Spudis asked the panelists what commitments the U.S. is not living up to under the President's Vision. Dr. Garneau noted that the U.S. will support research on ISS until 2016. The concern is that to do viable research, there has to be a certain amount of mass transfer capability. It is important to be able to reassure the country that there will be research on the ISS. Dr. Liebig highlighted several concerns, including crew size. A crew of six is needed to accomplish the planned utilization. From the new initiative, it appears that the U.S. will concentrate on life sciences. There is also a concern with download capacity when the Space Shuttle retires and only the Soyuz is available for that function. Another concern is what to do with the ISS if it is to be de-orbited. Finally, there is the general concern over the budget, i.e., the Moon Mars initiative taking funds away from other programs.

After a short break, Mr. Aldridge welcomed the special panel on "Media—The Big Picture": Mr. Rick Gelfond, Co-Chairman and Co-Chief Executive Officer of the IMAX Corporation; Mr. David Levy, Science Editor of *PARADE Magazine* and discoverer of Comet Shoemaker-Levy 9 and 20 other comets; and Mr. Craig Covault, Senior Editor of *Aviation Week and Space Technology* (AW&ST).

Mr. Gelfond spoke about the exploration message. He noted that IMAX is in about 30 countries. The first IMAX in China was Space Station in 3D (3-dimensional), and all of the

kids who saw it were excited and engaged. He talked about the passion in people for space. IMAX has made five space films that have been seen by over 85 million people—one of the most successful film franchises. Seeing an IMAX space film inspires people to become astronauts. IMAX space films inspire viewers to imagine the human possibilities and think outside the box. More evidence for passion about space is the recent Mars mission. People are interested in the right kind of message. The challenge is how to tap the demand and capture the public's passion. The space program and its benefits have been greatly under-marketed. For example, during the Mars mission, no web addresses were collected for follow-up—there was no way of getting back to people and marketing to them. Tom Cruise, the narrator for the International Space Station IMAX film, shares a passion for this. In the 1960s, the message was about competition with the Russians, acting on ideals, and being creative. We related with astronauts on a personal level. How do we reshape the message? The space program is being sold too narrowly—on a cost basis. We need to create an awareness of exploration on a broader scale. We need a leap of faith. The desire to explore is in our DNA (deoxyribonucleic acid) code. Over history, exploring societies have been the more successful societies. We need to talk about the affect on medicine, engineering, etc. How to we communicate the message? Many Americans have no example of role models for human potential. Film is one obvious way. There is a new 3D space film coming out—Magnificent Desolation—about the men who walked on the Moon, what they went through. We need to enlist the help of passionate celebrities. There needs to be commercials and advertising. IMG is a well-know sports marketing firm and is pitching a new reality series—the winner goes into the astronaut program. We shouldn't be close-minded about things like this. Perhaps NASA TV should be broadened. Perhaps there needs to be some organization (other than NASA) in charge of marketing.

Mr. Levy commented that the big picture is what the idea of going back to the Moon and on to Mars is about. There have been two major problems whenever the idea is asked. In our post 9/11 culture, why are we thinking about going to the Moon? We are fighting to save our way of life, and what are we saving it for? We are explorers. When we go to the Moon, we bring everybody with us. We have a cosmic heritage—a very basic and simple heritage and we see that when we look at the Moon. We go to the Moon in the hearts and minds of everyone. The Vision is bold. Mr. Levy offered a few ideas. We must make it inclusive—let it be augmented with a big push for science education. Another concern has been spending the money. Along with exploration, we should fund the global observing proposal that The National Oceanic and Atmospheric Administration (NOAA) has come up with. This is a plan to record the conditions of our lands, oceans, and atmosphere. When complete, we will have accurate positioning of major weather events and 7-day weather forecasts. We don't just explore Moon and Mars, we explore our own planet as well. Mars is a laudable goal, but lets focus on the Moon at the beginning—send people there and build a base. Expand our efforts to study how lunar resources can be exploited. Visit a near Earth asteroid. It would be a good idea to keep this Commission or some type of Steering Committee in place to oversee this initiative.

Mr. Covault stated that *Aviation Week* is into participatory journalism. It has been immersed in human and robotic space operations for a long time. It sees the benefits and challenges of space business around the globe. Around the world, space exploration is the universal

language. Mr. Covault cited some of his experiences in Tibet and China. The China space program is very real, including the increasingly large number of Chinese engineers. We are at the starting line again. The implications, especially for math and science programs, are profound. McGraw Hill has adopted several ideas from Sally Ride. Since the success of the Mars rovers, *Aviation Week* has been looking at what it can do on the news and education side toward manned and robotic exploration. Exploration has to be shared with the American taxpayers, and the media is the conduit for that sharing. NASA has lost the media on the ISS. Once assembly restarts, it has a chance to win the media back. ISS is defensible on a foreign policy basis and as a foothold for a lunar/Mars initiative. The robotic missions are becoming so productive, they might push human exploration further to the right in the schedule. We must have a much better assessment of risk than the current models provide. Risk assessments for the rovers rated them as extremely risky, yet they were very successful. How can NASA pull everything together for sustained support for the program to the Moon and Mars? Mr. Levy disagreed with any marketing approach that is “show biz.” He noted that NASA has a lot of work to do in this arena. Mr. Covault talked about his experience with the Mars rover team. No administration or Congress should underestimate the public’s willingness to share in that experience.

Mr. Aldridge commented that one of the themes is that this Vision is not just a NASA vision; it is a national vision. If it is truly a national vision, it must be justified from a national perspective. Should it be marketed at a higher level? Mr. Gelfond stated that NASA is not sufficient to do it on its own. Some new mechanism needs to be created, and it needs to include different constituencies—education, NASA, industry, and communication components. One of the problems is that it has been imposed upon NASA without many resources. You want to create an organization with broader cultural aspects to effectively communicate with the population. Mr. Levy cited the image of astronauts on the moon during Christmas of 1968 and how popular that was. As NASA goes from success to success, the missions themselves will be the publicity. We need to emphasize that we are exploring. Mr. Covault added that this Administration needs to spend some “political capital” on this initiative.

Dr. Tyson observed that *Parade Magazine* is largest and loudest of the media mouthpieces, and Mr. Levy is among the most articulate. How much more powerful a voice can we have? Still, not more than half of the public is in support of NASA’s space missions. What hope do we have to make this work? Mr. Levy indicated that we have to have a greater push for science education in our schools. We have to write a science article so that it does not lose the reader. Those readers must have a better background in science. Our journey back to the Moon should begin in an elementary school. The next generation should have science as a part of their daily lives. In response to a question from Gen. Lyles, Mr. Covault indicated that the other part of McGraw Hill (publisher of *Aviation Week*) is in education—math and science. *Aviation Week* works to bring the two parts together. With respect to the aviation piece, there will always be people seriously interested in aviation, but there has to be a more serious emphasis that space is part of the aviation family. In response to a question from Dr. Zuber on untapped potential for human exploration, Mr. Covault commented that we will have to rebuild the human side. The real interest will continue with the rovers and Cassini as it moves in on Saturn. The Mars program will have sustained returns. Mr. Levy added that

the Web can help decide how we observe space. It will play a tremendous role and we need to take advantage of events that come to us that can get people interested. Mr. Walker posed some questions: What will give people more of a sense of going? Are there things that could make the program more appealing to the public? Mr. Gelfond suggested making this a “first person” experience rather than a “third person” experience. Technology has enabled much more of a first person experience. We are not getting to the people who don’t yet have the passion. It might be a good idea to create a website where people can direct experiments or get results, talk to people who are directly involved in the mission, etc. Mr. Levy noted that there is a Shuttle simulator at the Discovery Center in Arizona. It would be great if NASA could do more of that—working with museums to give people a hands on experience. Mr. Covault added that the Mars rovers have done a great job of public outreach and personal experience.

After a short break, Mr. Aldridge welcomed Mr. Sean O’Keefe, the NASA Administrator.

Mr. O’Keefe recounted what has brought everyone to this point. After the Columbia accident, the intent was to find the cause, fix the problem, and resume the program. The much broader question was to seek a clarification of the nation’s broader space policy objectives. The President felt that an imperative had been building and it was time to think in terms of interagency activities and bringing together a coordinated approach. From mid-summer through December last year, the President directed the coordination of stakeholder objectives and asked for a comprehensive set of options. His engagement was the most extensive of any chief executive, and his guidance lent itself to the clarity of the directive. There was realization that the difficulties of working through the set of objectives would require a different way of looking at the issues, and that led to the establishment of the Commission. Mr. O’Keefe played a video that summarized exactly how the components of the strategy should be assembled. The clarity of the President’s charge has focused NASA’s direction. The objective is to implement sustained and affordable robotic and human exploration. One of the specific directives is a promotion of international participation and development of a space industry. NASA is seeking the Commission’s advice on how best to implement this. Exploration is at the Vision’s core. The President’s direction throughout has been active exploration in and of itself. The Vision will extend human presence and provide opportunities for innovation and partnering. This is not an Apollo-like program—it is a program that is a journey, not a race. It is not driven by an imperative. It will be a sustained program over a long period of time. It must be affordable. There is no way that the present organizational structure and the way we do business today will be the most appropriate to achieve the Vision. We must look at a transformational model that facilitates the strategy. The means by which to go about sustainment and transformation requires looking at three basic questions: What? Who? How? Mr. O’Keefe discussed these three questions. He noted that that the Vision is not a program; it is a system-of-systems. The President has not asked for a massive increase in resources; he has asked for a modest increase. The plan is affordable to the nation not just in 2005, but also in the long term. Over time, it will fit within the budget parameters. The plan builds on major NASA successes. The first action is returning the Space Shuttle to flight and completing assembly of the ISS. Other first steps include operating in deep space, e.g., Mars rovers, pushing the boundaries of science and technology, and leading the nation in the President’s Management Agenda. NASA is

exploring the best ways to move forward. The Agency will move rapidly to use the Commissions' recommendation to further shape the Vision implementation.

Mr. Aldridge noted that some are concerned about the uncertainties—the funding in 2005 and the Shuttle and ISS delays. Mr. O'Keefe stated that in the end, the President chose this approach. When Congress acts, that will be the result. In the process, NASA is providing any and every amount of detail asked for. There are only two elements in 2004 that have direct relationship to new elements of the exploration strategy: (1) establishment of a Centennial Challenge program; and (2) the cost to run this Commission. The 2005 issue is in doubt, because neither chamber of Congress has acted on any appropriation bill. NASA is continuing to move forward to comply with every recommendation of the Columbia Accident Investigation Board (CAIB). However long that takes is what it has to be. The Return to Flight (RTF) Task Group has examined and viewed as compliant NASA's approaches to the recommendations. Mr. O'Keefe indicated that he is optimistic about the progress, but we will not fly until we are fit to fly.

Dr. Tyson stated that the confusion on Capital Hill is a concern, and he asked Mr. O'Keefe to comment on the reaction of the Hill. Mr. O'Keefe replied that the credibility of the Agency has been tested on several occasions. He noted that he didn't fit the usual pattern of Administrator selection. NASA has worked for the last two years to restore credibility, and it is a long haul. It is not done overnight or by the appointment of anyone. It must be a sustained effort over time. Mr. O'Keefe admitted that that when he doesn't know something, he says so, rather than try to provide an answer that the questioner wants to hear. A fair amount of reputation building is necessary, and this takes time. An important caveat is that NASA is involved in a risky and unknown set of activities. It is by its very nature risky and the Agency that will ride the edge of the credibility curve and the technology curve.

Mr. Fiorina observed that transformation means something different from reorganization or restructuring. She asked Mr. O'Keefe to comment on the difference. He indicated that a reorganization effort would be undertaken in order to be more efficient in carrying out a stated set of objectives. Fundamentally, the goals and objectives would be similar to what they were yesterday. A transformation means an adjustment in the way that you look at the program. The Vision is very expansive, broader than what the Agency had been dedicated to in the past. We have been organized to do things as we did yesterday. We are now focusing on the broader goals of the exploration agenda; it is a more strategic view, more systemic rather than programmatic. The transformation objective is around strategic goals as opposed to optimizing efficiencies.

Dr. Zuber commented that some parts of the scientific community felt disenfranchised after the Vision was announced. The way that we have thought about the process may need to be re-examined. What is happening with the Vision is that it will be creating capabilities that will enable us to go out and explore in ways that we haven't been able to before. The communities may need to think about what kind of science they could do if they had these new capabilities. Mr. O'Keefe agreed. The science agenda should still pose the questions, and it should utilize the capabilities to seek answers to the questions. What is different is not asking scientists to assume the role of program managers or engineers. Part of what is being

created is the talent to look at this as a system-of-systems, and as a systems integration challenge. The scientists will still focus on the questions and how to go about answering them. For example, Project Prometheus is looking at power capabilities that will liberate scientists from power limitations.

Mr. Jackson asked about how to deal with the private sector. If there is a need to off-load things to the private sector that it can do adequately, how do you manage that over time, e.g., procurement structure, regulatory changes, etc. Mr. O'Keefe indicated that NASA is looking for guidance from the Commission. There is little desire to maintain capacity capabilities that NASA could request from any private sector capability. We have limited experience in forecasting the market and when we should transition, and NASA is looking to the Commission for those types of recommendations. NASA is looking at retaining those things that only NASA can do.

Mr. Walker expressed concern that Congress may take the \$900 million out of the 2005 request. He posed several questions: What happens at that point? Does this debilitate the program in a major way? Does it debilitate the ability to move forward with the Shuttle? Mr. O'Keefe indicated that he didn't want to speculate on what NASA may do. The Senate resolution supports the President's request; the House resolution is for the budget to be frozen at the levels of 2004. Both measures suggest strong support for the President's Vision. NASA hopes that the process will move along in a process consistent with the Senate resolution. Mr. O'Keefe noted that 85 percent of the increase in 2005 is the Space Shuttle RTF and Space Station. About \$140 million is associated with the CEV. This assumes that a lot of work is going to be done on that front. The immediate challenge is the Space Shuttle and Space Station. Regardless of the level of the budget, the objectives will be to return to flight and sustain the operations on ISS. Everything else will be lower priority than that.

Gen. Lyles observed that the Vision clearly articulates space. Will NASA evolve as a space agency alone, or will there be room for the aeronautics piece? Mr. O'Keefe indicated that this is a critical issue. Two factors drive us to conclude that there is a natural fit for aeronautics. There are a range of aerospace technologies that are blind to how they are applied, e.g., materials research and aerospace structures research. There are capabilities across the agency that could be utilized more efficiently in diagnostic capabilities, independent of the function. The second part of the equation is the long-term focus on breakthrough technologies. For example, over time, the X-43 technology could be the liberating means from a vertical launch dependency. If NASA doesn't do things like this, they won't get done

Audience Comments

Mr. Aldridge drew names at random for public comment

Bruce Gayner: The U.S. army created americasarmy.com, a simulation game. It improved the Army's image. Some of us working with NASA Ames did a similar program. Why can't we do a game like this to help get people excited. On-line things like this will get people involved.

Rob Wilk: With respect to education and youth, come up with a GI bill for this century. This would go a long way to put scientists and engineers into the stream. NASA is to be commended for its explorer schools initiative. Find a way to continue to expand programs like those. Look to give grants to grass roots organizations to reach out to different communities that need to hear what is going on. Please try to synergize and capitalize on what DARPA and others can bring to the table. Stay goal oriented, don't become destination oriented. There are answers through exploration that can address problems here on Earth and help improve people's lives. Everyone has benefits from space programs. Get the word out for the stakeholders to be public policy influencers. Please follow the JSF model and not the ISS model. A lot needs to be done with treaties and regulations to help the private sector grow in space.

Ed Fisher: Our efforts in space must concentrate on human exploration and Mars with creation of a new branch of civilization. The in situ resource situation produces a robust and highly productive program. The present NASA cannot implement the plans. In NASA's glory day, it had a clear goal and schedule, and it succeeded. Since then, NASA has spent more money and achieved less in terms of human exploration. Random programs have come and gone. Now is the time and Mars is the place. Congress must give NASA the direction it needs.

Thomas Hamilton (a retired college teacher who has worked in a planetarium and has dealt with the public as well as teaching astronomy): There is a profound interest, but a profound lack of knowledge. NASA has an office for supplying posters, but they don't do a good job on outreach and find out what the groups really can use. In NY, there are over 50 planetariums. There are very few people in the sciences that are active in politics. The various space organizations should be asking people to write letters.

Terry Logan: To sustain popular support, we need to enlist social forces. This requires appealing to society as a whole. President Bush has alienated the intelligentsia on this initiative because it comes from him. Success requires both style and substance. Space should be approached from a new paradigm—a vision of a freer culture living in peace. Younger generations are inspired by the Earth as an organism.

Adam Glass (a young person with an interest in space): Two ideas are important: (1) the creation of a space industry instead of a space program. This can reduce the cost of getting to orbit. (2) NASA needs to focus more on advertising and recruitment. Space is cool and interesting and needs to be presented that way. We need more people who can talk about what NASA is doing in an interesting way, like Steve Squyres. At school recruitment day, the Army is there, the Marines are there; NASA needs to be there. There are plenty of young people out there with good math and science skill as well as interest. You just need to reach them.

At this time, the Commission conducted a press conference, followed by an open deliberation of the Commission. The public is invited to subject comments and inputs on the Commission website: www.moontomars.org.

Commission Deliberations

Ms. Fiorina commented on sustainability rationale. The Commission is concerned about the sustainability of the mission because it requires a long-term commitment and bipartisan and public support. The requirement for the broad based support means that we have to answer a fundamental question: Why are we bothering at all? There are a number of compelling rationales: the greatness and glory of the mission, a great nation should embark on great missions, it lifts the national spirit. The Commission has heard comments that the Vision represents an opportunity for the US to lead the world in a positive way. We have heard about the scientific value of the mission. Exploration is a primary purpose and the scientific value goes to the ability to answer some fundamental questions, e.g., where did we come from? We have also heard about the inspiration of it all—the human as an explorer. However, these rationales are not sufficient to compel a broad-based, long-term bipartisan level of support. The most fundamental reason is: if we don't do it, someone else will. It is clear from the testimony that China, Russia, India and others have active space programs. Someone will eventually figure out how to send people into space and exploit that discovery. The U.S. should lead; if we don't, others will, and it is important for us to be the first to protect our leadership in the world. The 21st century is about technology, and leadership in this century depends upon technology leadership. Today, our leadership is threatened by nations focused on gaining technology leadership. There has been debate about outsourcing, but if we want to stay leaders in high technology manufacturing, we must lead in high technology industries such as space and aeronautics. Every dollar spent in space is spent here on Earth, and if we do not take on this mission, our technology base will erode. The second pragmatic reason is that technology leadership is key to economic leadership. U.S. children's ability to compete in the 21st century is on a decline. We are becoming less, not more competitive. To reverse that trend, we must reengineer our education system, and an inspiring mission like space can do that. We have to lead in those industries that “pull” that labor. The journey on Earth is what this is all about and it is worthy of public support. We have to help people make that connection. Sustainability will require grass-roots support. We have to provide recommendations on how to keep this a broad-based mission with broad-based support. We are talking about straightforward communication that educates people about the pragmatic and necessary rewards. There are innovative ways to galvanize grass roots support. We are hearing about ideas for that. It will be important to keep the support going, and to have a set of metrics and milestones. It is very clear that the private sector will have to be engaged in this journey, more deeply than in missions before. This includes entrepreneurs, private capital, and venture capital.

Gen. Lyles stated that this is a national vision, not just a NASA vision. That notion has been reinforced throughout the entire Commission process. Mr. O'Keefe has stated that the fundamental goal is to advance U.S. scientific and economic interest through a robust space exploration program. This brings into play other agencies and organization, from DoD, DoE, the Department of Education, universities, entrepreneurs, etc. It really is a national vision. We have to look at things differently—how we convey the message, how we manage, and how we leverage the resources. With respect to the management aspect, perhaps we need to revitalize the National Space Council to ensure that different government agencies that are

involved in space are coordinating their activities and working together as one team. Even within NASA, Mr. O’Keefe is looking at a different management structure and the Commission is making some recommendations. The Commission has seen ideas from DoD about a Lead Systems Integrator (LSI), and different techniques on how to take on a broad system of systems approach. It gives us a different aspect on how to leverage resources—the intellectual capital, the innovative management techniques, etc. Many could contribute resources to help accomplish this national vision. A final example is enabling technologies. These are key to accomplishing the initiative. As the Commission has talked to the NASA Centers, they have ideas on enabling technologies. We have asked the Air Force Research Lab (AFRL) as well, and they have sent in a list of enabling technologies. It is very much in harmony with what NASA has identified. The broader aspect of a national vision gives us an opportunity to look at things differently.

Mr. Jackson built on what Ms. Fiorina said. It is not just about NASA and its program. There are two big clusters of issues that testifiers are grappling with: (1) what is the right structure for the government to meet this objective for the long haul; and (2) how is the private sector to be organized for success and how do they relate to the government sector? Mr. Jackson talked about the second issue. We have to do this right. A crucial part is the business community that will engage and help drive the technology. The question of who is our workforce is important to begin with. The workforce at NASA and the workforce in the private sector is a national treasure. The job has to do with both enabling and supporting both our public and private sector colleagues in the right way. A cornerstone is that we need to forge a new and robust relationship between NASA and the private sector. We need to find a way to nurture a robust space industry. This is a national vision and a global undertaking. This is about taking private sector assets, tools, and innovation around the globe. Mr. Jackson discussed four terms: innovation, nimble, entrepreneurial, and spiral development. We have to find a way to institutionalize the ability to change constantly. Exploration will open up new opportunities. The entrepreneurial sphere is essential. The government doesn’t easily do innovative, nimble work, and we need to partner with the private sector. We have to learn through a series of progressive steps how to change. NASA’s charter speaks to the commercialization of space. It speaks to the importance of trying to find commercial rewards and utility out of space. This will be a sea change in the way that NASA deals with the private sector. It is about large and small corporations. NASA should do the things that are indispensably governmental. We should rely on the commercial sector to do what it can do, e.g., launches into low Earth orbit. Spiral development means buying a little bit, chewing it, and digesting it before taking the next step, and modify as we go along to take advantage of what we have learned. There are good management tools and experience that we must take advantage of, e.g., procurement tools and lessons-learned about engineering tools. The Commission has also found that prizes would be useful.

Dr. Leshin spoke from the perspective of an educator and a learner. She emphasized the importance of this vision for inspiring kids of today in math and science. The crisis in math and science puts us at risk because our children are not being educated adequately. We have heard from numerous educators. It is clear that a vibrant space exploration program will enable us to reach inside the minds of the youth of America and engage them.

Accomplishing this journey will be more engaging than we can image if we can involve them. Education is a clear priority for the Administrator. We must seek to redouble our effort, focusing on teachers and pre-teachers. We need to build on our successes. We need to educate the next generation workforce and engage universities in new ways and break down barriers to achieving the vision, for example the barrier between science and engineering. We can do this through relatively inexpensive investment, where teams gain hands-on experience and learn skills. There is a possibility of a virtual Space Academy to help train the next generation workforce. For outreach, we need to have a much more aggressive model than the government will be capable of. The endeavor is about more than science and discovery; it is about being a prosperous and innovative nation. This vision represents the most positive thing the government can do. It encourages us to imagine great discoveries. For the first time, we have the opportunity to ask and answer some of the most profound questions conceivable. The answers will help us understanding our place in the universe, and will change us. It will take the exploration vision to find the answers we seek. We look forward to celebrating the first person who walks on Mars.

Dr. Tyson noted that the Commission has reflected on the needs of the public to take ownership of this vision, or it will be taken from the national priorities by a disgruntled politician. The act of taking ownership is not new. The early astronauts belonged to the public. Back then, we all wanted to go, and today that is lost; however, it didn't stop people from taking ownership of the Hubble Telescope. Such ownership of space ventures remains possible. What this vision is is a portal on how we used to do science, and how we can do science moving forward. Until now, all we could image was putting a telescope in low Earth orbit, or a fly-by of another planet, and an occasional lander, restricted by budget. Now, with the vision, the palette has grown. We know how to build large structures in space, but will not limit ourselves to low Earth orbit—we can be at Lagrangian points, in free space, etc. We will not only build large structures, but hardware that does stuff, e.g., turn carbon dioxide into fuel and search the soils for hydrogen or water. We can now think about building mini-factories. We can imagine going to planets, landing there, gathering materials, and coming back. We need to charge the scientific community with rethinking what this represents as new opportunity, as a new palette on which to paint new dreams. The mechanism is already in place—the decadal survey. The community should look forward to revisiting the decadal survey in the context of the Vision. Science and technology lead each other. We need to find new mechanisms to ensure that the synergy remains in place—for the technologists to be in the same room with the scientists. There are three channels through which science is done. One is the kind of science done to expand our understanding of the cosmos. It is no less important in the total spectrum of science that must happen if we proceed in a sensible way. There is high public interest science, e.g., the search for water and life, and the search for planets. Doing high public and scientific interest science must be in the palette of science that is conducted. There is a third kind—the science of security. The security of the whole planet is at stake. There are thousands of asteroids that cross Earth's orbit, and they need to be characterized. We need to have as a goal the protection of the human species from these objects. Asteroids need to be on the agenda. Venus and Mars are wholly inhospitable to life. Something went wrong on these planets. Part of this Vision should be to find out what did go wrong to ensure that we are not turning those same knobs on Earth.

Dr. Spudis commented on one of the most visionary aspects of the exploration initiative—using space resources, something you can use off planet. It has inherent value to create new capability. The essence of sustainability is to create leverage. This is a great challenge and one of the most innovative. We need a new way of thinking about this. There is a synergy between science and engineering. There have been many presentations on resources. All of them emphasize the potential high leverage of lunar resources. The Moon actually contains the energy to bootstrap a space infrastructure. The materials are there. The issue is one of collecting and processing. There should be a significant R&D effort for this in the new initiative. The key to living off planet is not having to take everything there. One example of an early use is to cover habitation with the lunar regolith. The Moon is about 40 percent oxygen, and we know how to extract oxygen. We have found that there is hydrogen on the Moon. What we don't know is the state that hydrogen is in. NASA has developed a preliminary architecture to get the answers to these questions. Also, international missions to the Moon are planned. All will provide critical data that will allow us to assess materials on the Moon. The obvious next step is to go to the surface and make measurements. We need to conduct some ground research to experiment with different extraction processes. Those could be followed by flight demos. This is a missing hub of expertise in NASA—it is at the nexus of mining and aerospace. An office of planetary engineering could merge these two centers of expertise. The potential is revolutionary. If we can do this, it totally revolutionizes the paradigm of space flight. It will create new opportunities for spacecraft that can be refueled in space and provide routine access to the lunar surface and any orbit between low Earth orbit and the moon. All of our commercial space assets occur in this space. All of these things would be affected. This is at the heart of creating new capability. Exploration offers up commercial opportunity, and this is particularly true in the area of space resources. This is a classic example of an area ripe for transition once NASA has pioneered the way.

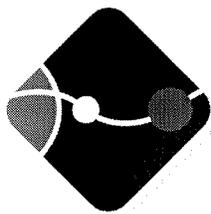
Mr. Walker noted that there have been question about whether NASA is capable of accomplishing the vision. NASA has a problem—it is cultural and it is debilitating. This is not news. It is a case where the culture and the infrastructure that worked so well in Apollo has become a hindrance to future development. NASA began to view itself as the only way that America could go to space. It gradually became unfocused; it became a little bit for everybody, and Congress contributed to that. The other problem was that NASA became an agency that was excluding people with ideas. To some extent, it became an exclusive club—a few got to go and the rest of us got to pay the bill. If this problem is to be solved, it must be within the opportunity to create a new model—NASA becomes a crucial part of the whole that marshals resources. It becomes inclusive rather than exclusive. NASA needs to be able to reach out, get new entrepreneurs, and bring them inside. There needs to be a transformation. The Commission is encouraged by Mr. O'Keefe's thoughtfulness on this problem. This transformation will be essential to accomplish the mission. The budget can't support doing everything for everybody and adding on a new vision beyond that. It should include a NASA that has clear lines of authority; it needs to have structures that promote risk taking; an attitude of "yes, if" rather than "no, because"; NASA centers need to become economic models, places that contribute to the economy and where entrepreneurs feel comfortable coming into. There is a choice between the NASA that has been and the NASA

that can be. The current NAS has become unfocused, risk averse, and exclusive. The NASA that can be will be forward looking, inclusive, focused, risk-taking, and vibrant.

Dr. Zuber talked about the role of NASA Centers. It became apparent to the Commission that the NASA Centers would play a central role in implementing the vision, and a subset of the Commission did fact-finding trips to five of the NASA Centers. The civil servants, contractors, and university affiliates contain a remarkable, world-class expertise. Our fact-finding indicated an immense excitement about the NASA Vision. We were impressed with the level of enthusiasm with everyone the Commission talked to. The level of commitment at all levels is remarkable. Centers are important contributors to the state and local economies. They provide an educated workforce, attract private sector involvement, and are associated with nearby educational institutions where they contribute to basic and applied research and educational outreach. The Commission sees the Centers as local economic engines that could engage the private sector to a greater extent. They could be even more valuable to local and state economies. The Centers as currently organized are not optimally suited to carry out the Vision, because they were organized on a long ago history. In some cases, they have Apollo era infrastructure, they carry out programs that are not in alignment with the future direction of the agency, they have duplicative capabilities, and they contain a skill mix that is not in all cases a good match for the program of the future. The Commission has studied the composition of the present workforce and has raised a question of a new model. It has looked at a number of models, but has not made a decision on its recommendations. The transition to full cost accounting is leading to a structure that puts the Centers on a more even playing field with the private sector. There have been some recent compensation changes that have helped attract and retain highly compensated workers. Another possibility is to transition from the current situation to more temporary civil servant positions. There is a great need for infusion of younger workers, and there needs to be innovative ways to obtain the workforce of the future. One of the interesting things is that the promise of a permanent civil service job is not a requirement for NASA to recruit the next generation. People graduating today are looking for something exciting to do. The Commission discussed whether there would be some benefit for some of the NASA centers engaged in research to consider a Federally Funded Research and Development Center (FFRDC) model, e.g. similar to JPL, Lincoln Laboratory, and some of the other national labs. This model could facilitate workforce transitions, introduce university partners, and provide a vibrant culture of excellence and innovation. For operational centers, there is evidence that state and local authorities might be interested in contributing to infrastructure improvements and capitalize them in the long term. Local and state authorities could actually contribute to the running of the Centers. There has been a historical tendency for NASA employees to spend an entire career at a single center. This might be a negative in the desire to develop a broadly based leadership pool for the future. The Commission noted that at some NASA Centers, workers are now being encouraged to move. Many of the things observed have all followed the common theme of the workers reaching out, and looking outward instead of inward. NASA employees have the opportunity to lead on the journey. Mr. Aldridge noted that once an FFRDC is created, there is an opportunity for that FFRDC to work on other opportunities. Dr. Tyson added that converting to an FFRDC would require porting those who are civil servants into the employment profile of an FFRDC.

Mr. Aldridge summarized what the Commission has heard. First, there is delight that there is now a Vision. The goal is very important, but the journey is also important. Achieving the goal and the benefits of the journey will require that fundamental changes be made. It must be a national effort, and should be managed in a way that utilizes resources of multiple federal agencies. It must be sustainable over decades. We must transition to a space faring nation, leading to a space-based industry. It requires more private sector involvement, where NASA does the hard stuff, and industry does the rest. International participation is important. The NASA organization must be more integrated, focused, and aligned with the vision. It must be managed as a system of systems. Because of education and workforce issues, our ability to do this will be declining over time. We need incentives for math, science, and engineering for the goal and the journey. The Commission will be making recommendations in these areas.

Mr. Aldridge adjourned the meeting at 5:45 p.m.



President's Commission on Moon, Mars and Beyond

WITNESS LIST AND TIMELINE FOR NEW YORK CITY, NY HEARING

*Hearings will take place at the Asia Society
725 Park Avenue, New York City, NY 10021*

Monday, May 3, 2004

- 1:00 p.m. Welcome and Introductions
Chairman Pete Aldridge
- 1:15 p.m. International Space Partnerships
Daniel Sacotte, European Space Agency
M. Philippe Berterottière, Arianespace
Hiyoshi Higuchi, JAXA
- 2:00 p.m. Lunar and Other Space Science
Dr. Tony Tether, Defense Advanced Research Projects Agency
John Delano, University at Albany (State University of New York)
Ariel Anbar, University of Rochester
- 2:45 p.m. BREAK
- 3:00 p.m. Space to the People!
George Whitesides, National Space Society
Nick Eftimiades, Federation of Galaxy Explorers
Frederick Hauck, Association of Space Explorers
Louis Friedman, Planetary Society

Commission adjourns

Tuesday, May 4, 2004

- 9:00 a.m. Welcoming Remarks
Chairman Pete Aldridge
- 9:05 a.m. Sustainability and Management
Roger Krone, Boeing
- 9:30 a.m. Astrophysics for the Beyond
Catherine Pilachowski, American Astronomical Society
William Smith, Association of Universities for Research in Astronomy
David Spergel, Princeton

Tuesday, May 4, 2004 (continued)

10:15 a.m. BREAK

10:30 a.m. Space Prosperity and Resource Development
John Higginbotham, SpaceVest
Joel Greenberg, Princeton Synergetics
Miles Walton, Morgan Stanley

11:15 a.m. International
Marc Garneau, Canadian Space Agency
Representative, German Space Agency

12:00 p.m. LUNCH

1:00 p.m. Media – The Big Picture
Rich Gelfond, IMAX
David Levy, *PARADE*
Craig Covault, *Aviation Week*

2:00 p.m. ***BREAK***

2:15 p.m. Sean O’Keefe, NASA Administrator

3:00 p.m. Audience Comments

3:45 p.m. Press Conference

4:30 p.m. Deliberation of Commissioners

###

President's Commission on Implementation of United States Space Exploration Policy
New York, New York
May 3-4, 2004

COMMISSIONERS

Edward C. "Pete" Aldridge (Chairman) of Virginia

Carleton S. Fiorina of California

Michael P. Jackson of Virginia

Laurie Ann Leshin of Arizona

Lester L. Lyles of Ohio

Paul Spudis of Maryland

Neil deGrasse Tyson of New York

Robert Smith Walker of Pennsylvania

Maria Zuber of Massachusetts

President's Commission on Implementation of United States Space Exploration Policy

**The Asia Society
New York, New York
May 3-4, 2004**

ATTENDEES

Name

Affiliation

5/3/04

Akutsu, Takao	JAXA
Antigrano, Alica	
Atkins, Edward G.	Kagaku Productions
Bedard, Gery	Planetary Society
Brandt, David	Lockheed Martin
Cerrone, Eugene	NSS
Contursi, Paul	Mars Society
DaCoasta, Neil	IFF
Ejtenieds, Argering	
Fisher, Edmond B.	Mars Society
Gefe, Elenn	
Giannantonio, A	
Gibbs, Graham	Canadian Space Agency
Gibbs, J. Mrs.	Canadian Space Agency
Glass, Adam	
Hamilton, Thomas W.	Planetary Society
Hannon, Michael	
Harris, Edward	
Huber, Ralf	German Aerospace Center
Kirman, Joel	NY Sec, AICHE
Koyama, Masato	JAXA
Krezel, Alexa	George Mason University

Krezel, Jonathan	NASA
Macciardi, Robert	
Mowry, Clayton	President, Arianespace, Inc
Murphy, Kenneth	VP-NSS-Nerth Texas
Pankanin, Candance	National Space Society
Pau, Mour	
Pulham, Elliott G.	President & CEO, Space Foundation
Robyn, Cary G.	Terran Consciousness
Schneider, Joel	Sesame Workshop
Smallberg, Ralph	
Wilk, Thomas	
Wille, Norman	NSS
Zervas, C.A.	

05/04/04

Antignano	
Berman, Andrea	
Boethhoff, Kristin	Mars Society of New York
Brandt, David	Lockheed Martin
Brandt, Galen	Digital Space
Cervone, Frances	National Space Society
Coffino, Myrna	NSSA
Contursi, Kyca	Mars Society of New York
Contursi, P.	Mars Society of New York
Damer, Bruce	Digital Space
Enriguy, Hermie C.	Raybingcat
Fisher, Edmond B.	Mars Society
Gelfond, L	
Gelleyhn, Shawn T.	NASA LaRC
Glass, Adam	
Guillaume, Richard	Mars Society of New York

Hamilton, Thomas W.	Planetary Society
Hanson, Mike	
Murphy, Ken	VP - NSS- NT
Newhall, Mike	
Nordlund, F.	ESA
Olson, Thomas A.	The Colony Fund
Pankanin, Candace	National Space Society - NY Chapter
Pegmone, John	NYSkies
Perrone, Eugene	NSS
Pimenta, Manuel	Space Frontier Foundation
Robyn, Cary G.	Terran Consciousness
Sachdev, Savi	Canadian Space Agency
Saivetz, Wendy	
Struvis, V	NSSA
Tyson, C&S	Neil Tyson
Udell, Allan	AMS DMV
Vaudo, E	ESA
Wen, James	
Wilk, Rob	
Wolfe, S.	