

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

**Atlanta, Georgia
March 24-25, 2004**

PUBLIC MEETING MINUTES

Approved

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**Steven G. Schmidt
Executive Director**

Approved

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

President's Commission on Implementation of United States Space Exploration Policy
Georgia Center for Advanced Telecommunications Technology
Atlanta, Georgia
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Wednesday, March 24, 2004

Welcome and Introductions

The Honorable Pete Aldridge, Chairman of the President's Commission on Implementation of U.S. Space Exploration Policy, welcomed attendees to the Commission's third Public Hearing and introduced his fellow Commissioners:

- Ms. Carly Fiorina, Chairperson and Chief Executive Officer of Hewlett Packard, which she joined in July 1999. Her roots are deep in technology, having served in senior executive leadership positions at AT&T and Lucent Technologies.
- The Honorable Michael Jackson, senior vice president for AECOM Technology Corporation. He is a former Deputy Secretary of the U.S. Department of Transportation.
- Dr. Laurie Leshin (who would be joining the hearing later in the day), Director of the Arizona State University Center for Meteorite Studies and the Dee and John Whiteman Dean's Distinguished Professor of geological sciences at the University. Her research is focuses on understanding the formation and evolution of our solar system and its planets. She currently leads a team that is designing a potential mission to Mars for collection of Mars soil samples.
- General Les Lyles, former commander of the Air Force Materiel Command. He was in the Air Force for more than 35 years, rising from the Air Force ROTC program to become a four star general. He has been involved in space throughout his career.
- Dr. Paul Spudis, planetary scientist at the Johns Hopkins University Applied Physics Laboratory. His specialty is the geology of the moon, and he has also studied the geology of Mars, Mercury, and many other worlds.
- Dr. Neil Tyson, astrophysicist and the Frederick P. Rose Director of the Hayden Planetarium in New York City. His professional research interests include star formation, exploding stars, dwarf galaxies, and the structure of the Milky Way.
- The Honorable Robert Walker, chairman and chief executive officer of The Wexler & Walker Public Policy Associates, a firm specializing in telecommunications and technology issues. He served in the Congress of the United States 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.

- Dr. Maria Zuber, E. A. Griswold Professor of Geophysics and Planetary Sciences at the Massachusetts Institute of Technology and leader of 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.
- Executive director of the Commission, Mr. Steven Schmidt. He serves as Special Assistant to the NASA Administrator and is the Designated Federal Official (DFO) for this Presidential Commission.

Mr. Aldridge reviewed the processes 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. Through the Commission's website—www.moontomars.org—it has been accepting comments from people around the world. More than 4,700 responses have been received on the website to date. Every input is being read. About 75 percent of those contacting the Commission have been in favor of this sustained journey. Many of those who express concerns do so because of cost. The Commission must make recommendations that are affordable and sustainable over several decades. It is looking at its task through four themes or approaches: management structure for such a large project; inspiration of the nation's young people; the science agenda for the next several decades; and strategies to ensure the nation's competitiveness and maintain its prosperity. In addition to Atlanta, the Commission plans to have public hearings at two additional cities: San Francisco and New York. The Commission will prepare its report and present it to the President and the NASA Administrator, 120 days after its first meeting (February 2, 2004) on June 7, 2004.

Mr. Aldridge acknowledged and thanked the Commission's hosts, Dr. Wayne Clough, President of Georgia Institute of Technology, and Nikil Jayant, Executive Director of the Georgia Centers for Advance Telecommunications Technology (GCATT).

The first panel "Space Entrepreneurs," was represented by the following individuals: Mr. Elon Musk, Chief Executive Officer (CEO) and Chief Technology Officer of SpaceX and co-founder of PayPal and Zip2; Dr. Peter Diamandis, Chairman and CEO of ZeroGravity Corporation; and Mr. Jeff Greason, President and CEO of XCOR Aerospace.

Dr. Peter Diamandis spoke on three subjects: X Prize, space entrepreneurship, and risk. Recent studies say there is a billion dollar plus market for people wanting to fly in space. X Prize offers a \$10 million cash prize for the first team to privately finance and build a ship carrying three people to a 100 km suborbital flight, launching two flights within a period of 2 weeks. A winner is expected in the next 4 to 6 months. There are 27 teams from seven nations. Dr. Diamandis noted that he also had a role in the NASA Centennial Challenges \$25 million in prizes. Prizes are a way to achieve fixed price science and engineering and get people excited about participating in space. People are starting to talk about a new generation of space entrepreneurs.

Dr. Diamandis encouraged and urged the Commission to embrace and support these companies. Most of these companies are focused on the real market – people who want a chance to fly. The suborbital vehicles are small. He noted that we cannot get to operational robustness with only a dozen flights—three or four flights a day are needed. That is how to get to robustness and safety. He urged the Commission to support the public space flight marketplace. The Department of Defense (DoD) and NASA could then buy these flights. With respect to risk, Dr. Diamandis stated that we have become so risk averse that we are forgetting how to innovate. We must acknowledge and take risk. We cannot have breakthroughs when people are not allowed to fail. He urged the Commission to recognize the need for risk and educate the public that space is risky business.

Mr. Elon Musk addressed the Commission via videoconferencing from Los Angeles, California. He noted that the cost and reliability of access to space has changed little since the Apollo program. We have reduced costs in other technological areas, e.g., the computer. The exception is spaceflight. One asks the question “Why?” Mr. Musk contended that space flight suffers from creative destruction. There has been no successful new entry in spacecraft in decades. We must create a fertile environment for space flight companies. Progress in cost and capabilities will then be dramatic, as in other technology sectors. The Internet showed little growth for over two decades until private enterprise entered the picture. The President’s Vision is achievable within the current schedule and budget, but only by making use of new entrepreneurial companies and not following the old paths. Mr. Musk discussed some strategies for achieving the Vision. One of these is the increasing use of prizes—this approach can pay enormous dividends. History is replete with examples. Competing stokes creativity. One option would be to parallel every NASA contract award with a prize. NASA’s Centennial Challenges prize program should be extended. Another strategy is to support new entrants into space launch. The cost of access to space drives the cost of spacecraft. We must improve the prize per unit to orbit. We need to create the system that will create this improvement. SpaceX was established to improve the cost of access to space. The first vehicle (suborbital) will soon be demonstrated. The second-generation vehicle will provide a factor of 10 improvement in cost and reliability and will have engine out capability. Mr. Musk stated that he believes in the commercial market for human transportation.

Mr. Greason presented his views on private sector space transportation. His company, XCOR, was founded on the belief that dramatic decreases in cost are possible. Mr. Greason showed a video clip on XCOR’s work over the last few years. The EZ-Rocket was intended as a rocket demonstrator. He would like to see the nation move forward in a bold move of exploration. We cannot succeed by recreating the Apollo program. It is likely that before the end of the year, one or more companies will have a suborbital flight. It is a time of great dynamism and risk-taking by private entrepreneurs in space. Private entrants are developing vehicles on a three-year timescale. It is possible that reusable space vehicles will be available by 2014. NASA must plan missions in a way to exploit these capabilities as they arise. NASA can buy space transportation services on the commercial market and should use commercial means as their sole means of transport to orbit. There are launchers in the 10-20 ton range. Current funding will not support a NASA-unique launch vehicle structure and the payloads for it. The launchers do not have to be selected today. Mr. Greason recommended putting the launcher out for bid and taking the ones that are inexpensive. The way to reliability is greater path-going. The way to safety is a robust

escape system. In the interim, companies have the ability to develop components cheaply and quickly. American can afford to dare and do great things. We have to use what we have, live off the land when possible, and build expensive unique equipment when nothing else will do the job.

Mr. Aldridge asked about the incentive for the \$50 million investment needed to compete for the X PRIZE. Dr. Diamandis explained that if the prizes get high enough visibility, the entrants would come—look at the America’s Cup. It is the glory of it and the prize “credentials”. People who want to compete for these prizes do not go to venture capital firms—they go to sponsors for advertising. About \$20 billion is spent in sponsorship and very little of it goes to space, and it could. There are private companies that could go to the Moon today in three years if the capitalist spirit is unleashed.

In response to a question from Mr. Walker on the potential response to a request for proposal (RFP) or request for information (RFI) for a plan for filling the gap after the Shuttle retires and before Crew Escape Vehicle (CEV) is available, Mr. Greason noted that traditional procurement programs do not always produce the desired product. Private companies must know that there is a market there. Prizes are very exciting, but markets are more exciting. NASA has a core ongoing budget wedge for an exploration mission; it should put a large wedge of this out for bid. That is a real market.

Mr. Musk added that Space X would respond to such a request. It has strong interest in servicing the Space Station, including providing human transport.

Dr. Tyson questioned why the prize approach is only just now being pursued. He commented that the President’s Vision is not a vision that has the luxury of waiting around for something new. It will take advantage of something that shows up. He asked Dr. Diamandis about the potential mismatch between the winning of prizes and execution of a vision with a timetable. Dr. Diamandis stated that the prize approach was not taken ten years ago because the problem was availability of capital. The venture capitalists would not support it. Prize money has credentialed the concept. In the early aviation world, the prizes were put up by newspapers to create news and sell newspapers. Mr. Greason added that until after the Space Shuttle Challenger accident, space was not open for private enterprise. There was the perception that private efforts were in competition with the government. In addition, regulatory risk is declining.

Ms. Fiorina asked the panelists to talk about the subject of risk. She indicated that she also shares the concern that we are becoming a risk-averse nation rather than a risk-taking nation. This moves away from the true American spirit. The issue of risk can potentially make this mission difficult. How should we speak to the people? Do they have a different tolerance for risk when it is entrepreneurial rather than government? Ms. Fiorina also asked about how venture capitalists could be more involved. Mr. Musk observed that we need to have a positive example of one company that has started up and done well in space; right now, we do not have any good examples. In fact, there is a big “graveyard” there. He noted that the venture capitalists were surprised when he tries to do something in space. A successful first launch by Space X may break the dam. As an example, he noted that the Internet was not initially seen as a commercial arena.

Mr. Diamandis commented that we have to embrace risk. We have 50,000 deaths per year in auto accidents, but we do not shut down roads. When Space Shuttle Challenger accident occurred, we stopped the space program. There needs to be an active effort to let the public know that this is a risky business. Astronauts should publicly discuss risk. We do not know who the “heroes” are. On venture capital, we have zero successes. The government needs to play the advocate role more actively. For example, NASA does not want to give up the KC-135, even though Space X could do it cheaper.

Mr. Greason noted that a lot of time is spent working the regulatory issues. The only way to get safer is to allow risk. The only way to prevent risk is to freeze design, but the only way to get better is to allow technological change. On capital markets, success is something we need. A sustainable mission has to make money, and the market has to be there. Winning a competition has to be based on performance. For actual exploration missions, venture capitalists have the issue of private property rights in space.

In response to a question from Dr. Spudis on how the initial efforts to extract resources (on the Moon) would be transited to the private sector, Mr. Greason noted that in situ resource utilization is a critical component. The government will be developing some technology. At some point, there will have to be some discussion of property rights in space. There are legal challenges involved in property rights regime. Dr. Diamandis added that everything we hold of value on this planet is in infinite quantities in space. Once private rights are defined, the capital will flow.

Gen. Lyles stated that he was intrigued by the entrepreneurial companies that claim they can do space launch quicker, cheaper, and better than the government and asked the panelist to comment on the formulas that they are going to bring to the table to make it a success. Mr. Musk provided his “formula.” Before starting a company, put together best minds and ensure growing from every lesson learned in past. Solicit as much advice as possible from the DoD, and be dedicated to not taking shortcuts. Mr. Musk noted that he has received large support from the DoD and the commercial sector. There is a much greater reluctance in NASA to engage with any new company. For example, his company has never had a single visit from the NASA launch vehicle procurement office. Mr. Greason commented that his company is starting small and working up. His people often have more knowledge of the state of the art than some of the “experts” do. NASA can get cheaper than the Shuttle by procuring on the open market now. His advice is to start by buying on the commercial market with open procurement. This will accelerate the pace of new interest. Dr. Diamandis added that entrepreneurs could do better than the government because they have a willingness to take risk in areas that the government cannot. They take risks because that is what they need to do to succeed.

In response to a question from Dr. Zuber, Dr. Diamandis described what happens after the X Prize is awarded. There will be an “X Prize Cup.” All of the teams will be invited to come to one location once a year and fly as many times as they can during a two week period. During those two weeks, there may be 100 launches to space. This gives the public a chance to touch and feel these ships. Some will fly the highest; some will have the quickest turnaround.

In response to a question from Dr. Tyson on what could be done to facilitate buying on the open market, Dr. Diamandis noted that NASA has a big problem with risk—first, in procurement; second, there is test readiness levels (TRL) 1, 2, 3, etc. NASA has a position that it cannot fly what has never been flown before. This is an issue throughout the organization. Mr. Greason added that he did not have much optimism that NASA would be lining up to buy things commercially. There is always a reason not to buy—the risk is too high, interface issues, etc. The last 30 years are replete with many reasons. The question is: How can NASA and the new exploration Vision be used to accelerate entrepreneurial progress. Mr. Musk commented that he has had great experience with the DoD, but has no positive data point with the NASA launch vehicle procurement office. He agreed that everyone would benefit if NASA had an arm similar to the Defense Advanced Research Projects Agency's (DARPA's) role in DoD. DARPA is expected to take risks and accept failure (up to 50%).

Mr. Jackson stated that he was impressed with their success model. He posed the following question to the panelists: If you could start with an organization (like NASA) that is solely tasked with supporting the President's vision, is there some fundamentally government part that will not be met by commercial entities, or should the whole thing be commercialized, or should private sector innovation be integrated with the government—where is the dividing line? Mr. Greason observed that there is an inextricable government role. It is difficult to envision true exploration missions being done for profit. Prizes are a way to do some of that on the edges. However, if you look at successful explorations in the past, the mindset is different from Apollo. If you want propellant on orbit, there is no reason why you couldn't put out a contract for it. The myth of Apollo is different from reality. In 1962, NASA was a DARPA-type organization. NASA provided the key research and coordinated the project. That approach will work. Dr. Diamandis agreed that there is a government role where NASA is the sole customer (e.g., exploration). Where there may be other customers, NASA should let the markets develop. When the capital is there, the problem will be solved.

Mr. Aldridge concluded that the panel provided two basic messages: (1) there are values to prizes—getting people motivated, stimulated, the prestige, etc.; and (2) commercialize those things that can be commercial that are outside of the inherent government role, e.g., the things that support exploration such as communications satellite, mapping, etc. Ms. Fiorina added that there is a third message—there is a difference in approach, mentality, and value of risk taking. The culture is fundamentally different in an entrepreneurial community than in the government.

After a short break, Mr. Aldridge introduced the second panel from the host community, Georgia Institute of Technology: Dr. Narayanan Komerath, Professor in the School of Aerospace Engineering, Mr. Daniel Hegeman, a student in aerospace engineering and one of the crew of the Mars Society "Mars Desert Research Station", and Dr. Paul Ohme, the Director of the Center for Education Integrating Science, Mathematics, and Computing (CEISM).

Dr. Narayanan Komerath discussed "what happens beyond Mars exploration." The Vision mandates synergy of robot/human, science/engineering, and Moon/Mars schools of thought. Today's showstoppers are no longer technical. The solutions require synergy and economic rationale. There must be a space-based economy. Dr. Komerath discussed the evolution of a space-based economy. Today, the showstopper is the "billion dollar dive". Business plans for a

space-based enterprise face huge, early research and development (R&D) investment with no return for 10-plus years because of lack of access and infrastructure. The space-based economy answer is to cut launch cost and reduce the need for Earth launches. Today's generation wants careers in space. We must reach out to the public beyond science and engineering. People must participate and benefit. Dr. Komerath presented a five-point public message: (1) the immense benefits to all humanity from the space program; (2) the idea that space programs are not just all astronauts and rocket scientists—they involve people in a huge variety of endeavors; (3) the idea that the taxpayer's money does not get "burned up"—it is spent on Earth generation good jobs and more wealth; (4) Mars is a destination, but it is also a focused technology program, toward an era of economic opportunities; and (5) a clear idea of where the space program is really headed. The message must be inspiring, credible, and reliable. Show people that they have an active role in the space-based economy and the future.

Mr. Hegeman briefly described his background and interest in space exploration. He opined that the science and engineering challenges sometimes seem easy compared to the political front. Decision makers in the government have no incentive to take calculated risks, and most of the prime contracting for human space exploration is by large, inflexible companies. In addition, there are regulations and miscommunications between all levels of the hierarchy. This complicated structure prevents large numbers of great ideas from becoming reality. The President's call for a new space program is a great step in the right direction, but obstacles present at all levels of the government will impede progress. The U.S. should work to cooperate with other nations to increase its knowledge base and build worldwide support for the endeavor. It should set up a framework that embraces private enterprise and encourages individuals. It must decentralize or enact deregulation of its space efforts so that many can contribute to the President's plan. One of the major challenges is coming up with a plan to eliminate tasks and programs that are nonessential to the ultimate goal. NASA must become result-oriented. A shorter time span needs to be implemented so that things are done, e.g., a total time of 10 years rather than 2 decades, which is discouraging. One of the important things is sustainability in the space field—long term funding and real jobs. The Vision must open space to true private competition. More emphasis should be placed on facilities that allow a crew to operate a fully simulated mission. The Mars Desert Research Station is an example of what the private sector can do.

Dr. Ohme focused his testimony on NASA sponsored K-12 programs—their role, their history, and their future. A large part of any NASA mission has always been to include an educational component for the K-12 student population. In the past, NASA's funding has been tied to missions. NASA is currently employing a team approach, which requires participation by a building principal and a team of teachers and students. The educational research community has identified several factors characteristic of good programs: the instructional process must be content rich and the classroom teacher must be knowledgeable and current in the field; enrichment activities for teachers and students must be in line with community expectation, state and local curricula requirements, and existing classroom resources; enhancement activities for a teacher must be presented as part of the local School Improvement Plan; and local and partner support and follow-up of the enrichment activity to assure its effective transfer to the classroom.

He discussed a partnership currently underway in Georgia involving the State Department of Education, Georgia Tech's College of Computing, and corporate partners. The goal of this project is to increase the number, diversity, and quality of the students completing high school in Georgia with computing skills. Dr. Ohme stated that the essential component of a long-term space exploration program is the creation of a scientifically literate electorate as well as the creation of a professional science, mathematics, engineering, and technology (SMET) workforce. NASA needs to implement a K-12 agenda that is based off knowledge gained from experience and research.

In response to a question from Mr. Aldridge, Dr. Ohme noted that the teachers are a good cost investment.

Mr. Hegeman indicated that his testimony reflected the majority of the more motivated of his peers. In response to a question from Dr. Tyson, he noted how he became interested in this major—by the promise held by many opportunities. The market is cyclical, and he is optimistic that it might be on the upswing.

In response to a question from Dr. Tyson on students entering the field, Dr. Komerath noted that currently, there is an all-time high in aerospace engineering. The students are optimistic about a future in space. With respect to a space-based economy, Dr. Komerath observed that as time progresses, there will be opportunities to generate services, then it will make more sense to extract resources. Once the infrastructure has been built, the interest will increase. The key is how to get to the steady state. Exploration is key to developing an economy.

In response to a question from Dr. Zuber on how to address the Vision, Mr. Hegeman commented that there is lack of education about the whole process. The leaders and heroes of our society are taking us where we have never been. We have to plan for future generations. We need the people with the ideas and they need to be the ones making the decisions. Dr. Komerath added that his school has tried to remove discipline barriers and convince people that they can continue to learn beyond graduate courses.

Mr. Aldridge introduced the third panel on “Developing Public/Private Partnerships:” Capt. Winston Scott, Executive Director, Florida Space Authority, and Mr. Tim Huddleston, Executive Director of the Aerospace States Association.

[Mr. Walker recused himself from the interaction with Capt. Scott because his company has a relationship with the Florida Space Authority.]

Capt. Scott discussed the Florida Space Authority, which has been a key partner to NASA, United States Air Force (USAF), and the commercial sector. Its mission is to develop Florida as the world's premier space enterprise center. The Authority is a subdivision of the Florida state government, created as an “airport authority” for rockets to provide facilities and other support for new vehicles and missions developed by the commercial sector. Capt. Scott noted some of the spaceport facilities that have been state owned or developed. Activities have generated a half billion dollars in general improvement. Space is officially recognized in all state documents as a mode of transportation. The Space Authority is developing a broader support strategy for the Exploration Mission. It has been working with NASA's Kennedy Space Center to establish the

International Space Research Park, anchored by the Space Life Science Lab. Capt. Scott urged the Commission to examine spaceport and range issues that need to be addressed in order to support the Exploration Mission. In addition to the need for infrastructure rehabilitations and modernization, new flexible and robust tracking technologies are available that could increase the overall capacity and responsiveness. States can play a critical role in moving our country forward and achieving the vision set before us.

Mr. Tim Huddleston briefly described the Aerospace States Association (ASA) and its unique mandate in regards to aerospace policy. ASA is the nation's only aerospace advocacy organization representing the states. Its goal is to ensure that the interests of the citizens from the member states are represented at the federal level with respect to policy formulation, economic development, scientific advancement, and the encouragement of excellence. Currently, over 40 states maintain active membership. Each state is represented by a governor-appointed delegate, usually the lieutenant governor. ASA advocates for both aviation and space. It works to advance its mission by conducting hearings and forums, formulating white papers, release position statements, and maintain outreach efforts. ASA classifies spaceports in three categories: operational, emerging, and planned. There are four operational spaceports: Kodiak, Alaska; Wallops Island, Virginia, Vandenberg, California, and Florida. There are emerging spaceports in New Mexico, Texas, and Oklahoma. Mr. Huddleston discussed ASA's vision—a national space transportation system that provides routine, safe, reliable, and economical access to space, and a national infrastructure consisting of spaceports throughout the nation. He noted several key national organizations other than ASA—the National Coalition of Spaceport States, the Office of the Associate Administrator for Commercial Space Transportation, the Advanced Spaceport Technology Working Group, and NASA-KSC's Federal Interagency Range and Spaceport Technology program. NASA is an extremely important agency that is populated with a lot of great talent, but NASA has continued to operate in the "Cold War vein." Mr. Huddleston opined that bureaucratic maneuvering and internal strife paralyze NASA. It needs to be allowed to function as an innovative agency, and Congress needs to get this message. We do not have a true space transportation system—state, federal, industry, and consumers working together. There is a general lack of basic research going on that supports this kind of concept. It is imperative that NASA be actively involved in the fundamental research to enable industry to build the vehicles to support this kind of system. NASA should enable the process. It is the role of government to enable—not do. Mr. Huddleston stated that ASA supports the Commission and the work it is doing. The American people envision space providing great opportunity to all citizens. The Commission has an opportunity to articulate the vision that the American people hope and desire for great opportunity from space. The American people are engaged and compelled by the American experience—the experience of great opportunity, and development of space can yield that opportunity. ASA will shortly release a document that articulates the American people's true vision for space. ASA will go on the road and meet with citizens to promote the President's Vision.

Mr. Aldridge asked Capt. Scott to expand on the International Space Research Park. Capt. Scott remarked that the Authority hopes that it will be an international gateway to space and attract researchers from other countries. In response to a question about the range standardization and automation project, Capt. Scott indicated that he didn't have a good status on this at the moment, but General Pavlovick wants him to aggressively seek a company that could provide the range

termination part of an overall range modernization program. Mr. Huddleston added that the Advanced Range Technology Working Group (ARTWG) has begun to look at the issue. ARTWG is making some significant recommendations to all of the players and participants in the Future Interagency Range and Spaceport Technology (FIRST) program.

Capt. Scott noted that the Florida Space Authority has put together a draft of a strategy of what it might do to support the Vision. The strategy addresses known infrastructure changes, e.g., man-rating the expendable launch vehicle (ELV) pads, and ground support equipment (GSE) needs. It is specific on what the Authority would ask the state to contribute. Mr. Huddleston added that the ASA has been engaging in the process and making recommendations. It can respond in any fashion. If X Prize is successful, ASA wants to respond to that. Mr. Aldridge indicated that it would be useful to the Commission to have that input. The public/private partnerships will be a key to the future. If there are some ideas, it would be helpful to have those. The Commission is looking for strategies for success.

Dr. Tyson noted that Commission has been surprised by the extent to which the Vision has become politicized. The biggest challenge may be whether it can survive the politics of the moment. He asked Mr. Huddleston what makes ASA work, and his thoughts on how the Vision could survive fluctuations in political flavor. Mr. Huddleston stated that the organization made a commitment early on that aviation and space issues are non- or bipartisan. Unfortunately, the Vision has been labeled as partisan, but it is not. To some states, space means a lot. In Vermont, aviation means a lot. Bringing aviation and space together was important. Ultimately, there will be a merge of aviation and space, and political leaders need to be in a posture of placing their state in that mode. Officials owe their constituents good economy, good jobs, and good education. ASA tries to put things in those terms—how it improves the economy, how it creates jobs, how it contributes to good education—for them and their children. This initiative is not for NASA; it is for the American people.

Gen. Lyles asked the panelists to share with the Commission their thoughts on what has contributed to success from the late 1980s and where we are today in terms of partnerships, facilities, etc. He asked if there are some policies and regulations that could help stimulate this. Capt. Scott noted that the removal of impediments among the partners has taken a new step. It is a result of the leadership that we have—the state government, putting people in positions of parity, fostering cooperation, etc. In response to a question from Mr. Walker, Mr. Huddleston indicated that from time to time there have been some discussions about taking over NASA facilities as state economic assets and becoming the managers of NASA Centers. The Florida Space Authority is empowered by the state, but operates more in the corporate world. This works very well. The states can help in the process and can play very active roles. There are states that would like to present some constructive dialog in how to do that. In response to a question from Dr. Leshin, Mr. Huddleston indicated that the ASA vision document is due out in short order (a matter of weeks). The ASA wants to make sure that it understands how its vision fits with the President's vision. He noted that he would like to submit this document to the Commission before releasing it publicly.

In response to a question from Ms. Fiorina regarding goals and timing, Mr. Huddleston indicated that we do not want to find ourselves “rushing to judgment.” However, many states operate

under the “get it done” mentality. However, in terms of timing, the further out the Vision, the less the American people are engaged. We need to keep the focus on the Vision. A shorter timeframe would be great, but not at peril to the mission. The technology is there and there are some entrepreneurs that are ready to do some flying. Mr. Huddleston encouraged a faster timeline. Capt. Scott agreed. He noted that if you drag it out too long, it becomes diluted. Once we decide that the Vision is good, we need to move forward. It is good for developing the overall space transportation system. We need to get commercial vendors developing space technology and providing services. In response to a question about the “pushback” among some of the states, Mr. Huddleston noted that there would always be naysayers for a better way to spend the money. However, we have an investment that we need to make in a new opportunity. If that investment will take care of the social ills through providing new opportunities, through developing new programs, industries, etc., then we are really flowing new dollars through the states and into the social programs.

Mr. Aldridge thanked all of the panelists and participants and adjourned the hearing at 4:00 p.m.

Thursday, March 25, 2004

Mr. Aldridge welcomed participants and attendees to the second day of the Public Hearing of the President’s Commission on Moon, Mars, and Beyond. He briefly reviewed the purpose of the Commission and introduced the Commissioners.

The first panel was “A Workforce Perspective,” with Dr. Michael Balzano, Executive Director, National Industrial Base Workforce Coalition; Mr. Charlie Botterding, Executive Director of the Society of Professional Engineering Employees in Aerospace and Executive Director of the Council of Engineers and Scientists Organization; and Mr. Jeff Rainey, Business Representative of District 166, International Association of Machinists and Aerospace Workers.

Dr. Balzano described the National Industrial Base Workforce Coalition and discussed the workforce perspective of issues that the Commission should be addressing. The Coalition exists as a group of local unions in about 30 states. It is “multi-workforce.” It spans the entire spectrum of the American workforce including scientists, engineers, professional and technical workers, production workers and those who provide services such as security and logistics. He noted that the Coalition has always been caught between science and entitlements. Throughout the battle of Space Station after Challenger, the Coalition took a generic stance—it was trying to save the entire industrial base supporting the Space Station. The Coalition entered the public policy debate at many levels and provided a continuous dialog. It worked very closely with the National Space Council. There was a President committed to the vision, a nation committed to the vision, and there was a resounding yes. Today, the Vision is being sniped at from all directions and the critics are out. There is a pressing need for social, domestic programs. The Commission should focus on two things: preserving the industrial base, and looking at the workforce as part of the industrial base. Mr. Balzano offered some suggestions. The National Space Council should be reactivated. There is a need to “sell” the Vision. People need to understand that many of the benefits we enjoy in our everyday life are rooted in the country’s space program. They need to understand the importance of the human spaceflight program. The Coalition and its workforce have had to spend a lot of time and effort lobbying Congress. The

position of NASA in the budget—constantly juxtaposed with social programs (NASA in the VA, HUD, and Independent Agencies budget)—pits NASA against entitlement programs. There is a need to educate and excite the next generation of workers. Get the message to the NASA employees that are hanging onto other programs. Think about the number of people who testify. If the U.S. departs as the leader of the world space program, the nation will be on the outside and what will the next generation of kids do?

Mr. Botterding described his organization and offered his thoughts on the Commission's work. The Council of Engineers and Scientists Organizations (CESO) spans a number of unions representing engineers, scientists, and technical and professional employees involved throughout America's technological base in both the private and public sectors. The Council has been active in the public policy debate surrounding America's space program. Mr. Botterding's comments focused on science and technology, competitiveness and prosperity. He expressed his concerns about two things: the current and future conditions of our technological base, and the general public's awareness and appreciation of the good things that space exploration will provide. As our ambitions are going up, our capabilities are going down, and this is a serious concern and must be addressed. The workforce is atrophying, and there is a shift in universities from U.S. citizens graduating to foreign students graduating. Our technological base is aging and leaving. Who are we training? Who are we inspiring? Who are our heroes? It is not technological leaders anymore. What do we appreciate and do we have a holistic view of the systems—how our economy works? Putting people in space pushes the technological base and is the foundation of a prospering economy. Mr. Botterding emphasized that he supports the work of the Commission. However, there is a key message: before we reach Mars, we have to reach the general population. Technology is a critical sector and it is the source that drives the economic engine. We have concerns about America's technological community—pushing the envelope, training ourselves for the future. We have an obligation to the rest of the world to continue to lead. This program comes at a critical time. There is work to do to make sure we have the foundation that is required. Mr. Botterding asked the Commission to look at the big picture—focus to create the capability and stability that this program needs.

Mr. Rainey presented his testimony on behalf of the workforce that implements the technical aspects of the Space Shuttle program. He expressed its support for the Moon-to-Mars initiative and the preservation of the industrial base that will make such an endeavor possible. He noted that we have to do what is right and needed for the future. Most people do not realize what the space program has given to the nation and the world. We need to have the International Space Station. It is important that the space program stays intact and that we train people. Every dollar that is spent on the space program is spent on Earth. Mr. Rainey stated that the workers represented by his Association are the best and second to none. No one can fathom what wonderful things can come out of the space program. Space will be explored, and the United States should be the nation to do that. America must take the lead in space, be the dominant force, and have the workforce to make it happen.

Mr. Aldridge observed that the implication seems to be that we must do more than just a space vision to turn the workforce issue around. Dr. Balzano agreed and added that we have to find a way to go back to an educational system that has heroes. We are not focusing on heroes anymore. The pump has to be primed at the educational level.

In response to a question from Dr. Spudis about whether the space program should be in the defense department,

Dr. Balzano noted that the Secretary of Defense is very concerned about the workforce. In the 1980s, it was taboo to mention defense. The Space Station was saved, but a Russian partnership was essential. We have to make it clear that the space program is everybody's program, including DoD's.

Ms. Fiorina observed that the space mission is about competitiveness and prosperity at home. She posed the question: With respect to the preservation of industrial base, how should we quantify the industrial base that exists today so that people understand the magnitude?

Dr. Balzano replied that quantification today is depressing. Today, everyone is talking about the loss of manufacturing. The key is to fight for every manufacturing job we have. The manufacturing sector is falling apart. Reversing it is another story. Someone must set the pace for what we need to do to turn this around. Every technical person is all about increased productivity. We need to acknowledge that we need to invest in the future. We have to create a vision that is sustained. We must get the message across that there is something in this for everything.

In response to a question from Dr. Leshin on job retraining, Mr. Bofferding noted that if we train the population as engineers, costs would go way down. In retraining, we must ask how far we are moving those skills. If we are trying to shift service sector to high technology, that is "heavy lifting." We must get people to think about retraining and continual education at the start.

Dr. Tyson added that the concern about heroes is a real one. He asked the panelists what they thought we should do or continue to do. Mr. Botterding observed that not everybody is doing his or her job in this area. The union is beginning to do outreach and bring students along, but we need a holistic solution. Inspiration is one on one. Dr. Balzano added that we need to get this into the grammar school level where kids understand there is something there for them. We need to focus on heroes, the mission, and the challenge. There should be more school trips to NASA. In response to a question from Dr. Zuber on what an organization should tell people, Mr. Rainey stated that his organization tells people that they need to train and take every bit of education that they can; prepare to adjust.

Mr. Walker noted that labor played an important role in saving the Space Station in Congress. The work of this Commission is about implementation—how to get there. He asked the panelists their views on NASA. Has the Agency atrophied? Does there need to be a reorganization of NASA? If there is one thing that is foremost important for an implementation strategy, what is it? Mr. Botterding responded that an effort like this would take the entire technological base. One thing that can be done is to figure out a way to give a strong, long-term commitment so that people know they have a future. Dr. Balzano added that we have to find a way to assure people coming into this industry that there will be an industry. DoD is dealing with how to convince people. We need to convince the people that there is a future for them if they stay and if they get into it.

In response to a question from Mr. Jackson on how to talk to public union employees about correct alignment of skills, Dr. Balzano indicated that the DoD is very close to this issue and has taken a leadership role. NASA has to convince employees that there is a place for them during the transformation. It has to get Congressional support that it will not run out on the funding. If Congress does not come up with funding to support program, entrenchment will be accelerated. We have to keep the focus on tomorrow. Mr. Botterding added that his organization tells employees the truth, and then backs it up with action. Tell them your principles. The question is: Are we committed to technology and blazing the trail? Gen. Lyles observed that what resonates best is showing them value. Showing value to the engineering and technical workforce does more for the workforce. Another important aspect is mentoring in some form or another. Mr. Botterding agreed that there is a role for mentoring as part of the goal. We also need to show appreciation. There are many skills and abilities that are about to leave, and mentoring is a way to capture that.

Mr. Gary Payton, Deputy for Advanced Systems in the Missile Defense Agency, addressed the Commission on “Lessons Learned Regarding Managing a System of Systems.” He discussed implementation and how the Missile Defense Agency (MDA) has chosen to run its mission—to defend the U.S. and deploy forces, allies, and friends against missiles in all phases of their flight against all ranges of threat. Previously, there was a collection of several disparate existing and future programs. Now, those elements have been brought together in one major program with a single mission, integrated schedule, prioritized funding, and closely coordinated objectives. The MDA looked at historical approaches. Systems engineering and system integration provides a vital role. There are many functions of systems engineering. One of those is an architectural function that does trade analyses between elements. Another function is ruthless configuration control and rigorous interface control. The MDA mission is a daunting job, similar to what will be needed for the Vision. Its approach has been incremental, spiral development. Spiral development is based on realistic demonstrations that are proven in a representative test environment. Mr. Payton indicated that based on his personal experience (military and NASA), NASA as currently constructed cannot pull the job off. Before the current administration, NASA was composed of 11 separate “fiefdoms.” Each Center had its own prerogatives and legislative office. This perpetuates a set of hierarchies. Another problem is workforce management. At NASA, a graduate could enter a Center and progress to SES level, having stayed within one NASA Center. Under this regime, the individual does not learn the breadth of what NASA can and should do. This perpetuates the problem and makes it difficult for NASA to produce managers of systems of systems.

In response to a question from Mr. Aldridge, Mr. Payton noted that the MDA approach is a “national team” (a consortium of all major contractors). The award fee on a national team is much higher than a typical contract. There are growing pains with starting a consortium of this nature, but a national team does attract the best and brightest. The national team puts aside their heritage and makes trades analyses independent of badges. In response to a question on how to augment the government system engineering talent, Mr. Payton stated that based on the skills of the people, members of the team have been put in charge of systems engineering. The team is not a contractor; it is a partner of the engineering office. Mr. Aldridge added that the system integrator role provides for the tradeoffs, but that entity cannot bid on the production contract. Mr. Payton added that top down vision, guidance, and continuous reinforcement hits the

President every year. He makes the decision on the scope and pace of the program. This “top cover” has been a superb enabler in making progress. Additionally, that has helped avoid much of the bureaucracy at the Pentagon. Gen. Lyles observed that the Exploration Vision is a national vision and will take continuous reinforcement and leadership from the top. Mr. Payton suggested that perhaps the nation needs a “Secretary of Science and Technology” at the cabinet level.

In response to a question from Dr. Spudis on how he would go about restructuring NASA, Mr. Payton offered the following comments: No one gets promoted to SES without serving at three Centers. The breadth of experience of people moving to SES must broaden at NASA. It would be helpful if NASA fit the model of the energy labs in their ability to hire and fire like industry. He noted that JPL is one of the leaders in innovation. Lincoln Labs is one of the innovators in workforce management. We have to get rid of the insular mentality that pervades NASA Centers. In response to a comment from Mr. Walker, Mr. Payton observed that DoD has several single purpose agencies like the MDA. Four demanding objectives stretch across the entire DoD. A project of this magnitude stretches across DoD, NASA, and other agencies. He suggested looking at establishing something that does the systems integration and then allows agencies to execute their pieces.

In response to a question from Ms. Fiorina on what is required in the mission phase, Mr. Payton indicated that the MDA defines each of the blocks (architectural) and technology assessments. There is also the program formulation job that looks at what are we trying to do, based on gap analysis. He offered some suggestion on a model for the Commission to consider for the Vision: have a workforce and part of the organization that is carved out and looking for the newest entrepreneurial ideas; constantly screen successful phase 2’s and encourage team arrangements between large companies and small company innovators; have to have an aggressive, forward-moving approach.

Dr. Zuber asked Mr. Payton to share some of his experiences on how he has dealt with different procedural ways of doing things. He noted that the Air Force works different from the Army. However, because missile defense is a top priority, MDA is able to encourage those individuals who do adopt the MDA practices. MDA implements and imposes certain standards through configuration and control board (CCB) process. It implements consistent mil specs and federal standards. It uses promotions, awards, and notoriety for top performers. This is a crucial element in getting people to adapt. In terms of time spent in the formulation phase, Mr. Payton noted that almost all of 2001 was spent in formulation. The formulation phase takes at least a year. Getting the goal penetrated throughout the organization is a continuous job.

Mr. Aldridge introduced the next panel, whose theme was “Safe on Mars:” Mr. Frederick Hauck, President and CEO of AXA Space; Professor Harry McSween, Jr. from the Department of Earth and Planetary Sciences at the University of Tennessee; and Dr. Ronald Turner, principal physicist at the ANSER Corporation.

Mr. Hauck discussed the background and results of the National Research Council (NRC) report, “Safe on Mars.” Several years ago, the NASA established the Mars Exploration Program/Payload Analysis Group (MEPAG) to propose the objectives and measurements

essential for investigation of Mars. NASA asked the NRC to be an independent filter on the proposals and perform a study on the precursor measurements necessary to support human operations on the surface of Mars. The NRC study, "Safe on Mars," was presented to NASA in May 2002. Findings and recommendations were directed at the preparations for the first human missions to Mars, and the report addressed only those hazards unique to operations on the surface of the planet. The potential hazards were grouped into five areas: geological, atmospheric, radiation related, chemical, and biological. Mr. Hauck addressed each group of hazards. The greatest threats to the safe movement of humans and critical equipment on the surface of Mars will likely be degradation of mobility, instability, collision, and mechanical failures of critical components. Dr. McSween discussed some other geological hazards. The report tried to identify a minimum number of measurements needed to assess the hazards. Mars is very different from Earth in a number of ways. NASA should be able to design a good filtration system for dust management. However, there is one toxic metal that is still of concern: hexavalent chromium. If the Mars surface has this metal, NASA should measure the concentration in the soil. Dr. McSween discussed other materials that could be toxic and other measurements that would need to be made, e.g., acidity of Martian soil or dust, and organic compounds. The NRC suggested an approach to biological hazards: to adopt a concept of "zones of minimal biological risk." He noted the measurements that should be made in the search for life forms. Some approaches involve sending return samples to Earth. The Committee decided that a sample return was not absolutely necessary if measurements could be made in situ. However, because of the complexity of the measurements for in situ sampling, sample returns will probably be required.

Dr. Turner discussed radiation. It will be a serious hazard. NASA has underway a substantial ground-based program to characterize risk. The NRC study looked specifically at what radiation measurements need to be taken on the surface. The radiation on Mars is complex. How much the radiation changes depends on location, season, activity of the sun, and type of shelter. The radiation environment cannot be measured directly under all conditions, so NASA must rely on computer models. NASA has a project underway to complete the models. With continued development of the models, the surface can be simulated. The dose estimate produced by the models will be used to establish rules for day-to-day operations. It is imperative that the models be validated through direct measurement of the radiation on Mars. Dr. Turner noted some of the areas that measurements will need to be made. The NRC recommended that this be a priority in the Mars program, and that these validation measurements be conducted as soon as possible.

In response to a question from Mr. Aldridge on radiation measurements, Dr. Turner indicated that the community understands that there is a need for a radiation monitor on the surface, but it has not been manifested yet. In terms of Mars being kept safe from us, Dr. McSween indicated that this was not part of the charge, but NASA has a planetary protection officer whose job that is. NASA spends a great deal of effort and dollars in minimizing the biology that goes to Mars and elsewhere.

In response to a question from Dr. Leshin on sample return, Dr. McSween commented that the Mars Exploration Rover (MER) mission demonstrates that scientists and engineers can make the rover do amazing things. For a human program, we are looking at one astronaut directing a robot real-time, and this is one of the challenges for the robotic technology and interface with

robots on a more personal scale. It is very difficult to make instruments that can measure minute quantities of exotic chemicals and have them withstand the rigors of launch and landing on Mars. We need to know the problems as soon as possible if we are going to mitigate them. Mr. Hauck added that the backup material describes what needs to be done on Mars to avoid the need for a return sample. Mr. McSween noted that the zone of minimum biological risk might apply to the subsurface also. If NASA adopts this procedure, sample returns from the site would be needed. This provides a place from which to operate. Sending out robots could expand the zone. Dr. Turned added that the radiation measurements on Odyssey would be relevant. They could be used to propagate models to make some environmental estimates. The committee felt that belief is not enough; a hard and fast measurement is needed to validate the computer model.

In response to a question from Mr. Walker on how important it is to go the Moon to test some systems, Dr. Turner commented that in the radiation area, a radiation detector designed to go to Mars could easily be sent first to the Moon. A lunar testbed would be an outstanding experiment as a precursor to Mars. In terms of risk, he would sign up for a first flight—he does not feel that it is a huge risk. However, we will have to face the possibility of a higher risk than general population of coming down with cancer. Dr. McSween added that there is at least medium risk to a Mars mission. Risk is more from the problems in dealing with microgravity and radiation than from the Mars environment.

In response to a question from Dr. Leshin on how the needed measurements could dovetail with the existing Mars program, Dr. McSween indicated that the Mars Scout program (a modest cost mission with highly focused objectives) could be expanded to address many of these measurements. In addition, these measurements could be piggybacked on the science and technology missions. Dr. Turner added that it is often a challenge to get human measurement instruments on a science mission. There is talk about having a modified version of the Scout where every other opportunity, the primary objective would be flipped, i.e., science one time, human measurement the next. This would be an adequate approach. In terms of enabling technologies needed, Mr. McSween observed that with analytical instruments, there are technologies that need refinement or development, e.g., energy sources that humans will need. NASA has programs in place to develop the required instruments.

Mr. Buzz Aldrin, Apollo 11 Astronaut, presented testimony to the Commission. He recounted his background and how he became involved in space and looking at better ways of doing things. He has participated either directly or as an observer in the many commissions on space. In looking at the grand vision of transportation, he concluded that it would not happen unless we have a better way of getting into space. He founded his rocket design company, Starcraft Boosters, to advance his lifelong commitment to venturing outward in space, and the ShareSpace Foundation, a nonprofit organization devoted to opening the doors to space tourism for everyone. He noted that a specific vision for the future was greatly needed. Space needs an imperative. He shared some thoughts on implementation. One of the most crucial challenges is how to sustain it within budget, maintain continuity, and avoid the political criticism. The new challenge is the sustained exploration of space. We are constrained by budget realities. What we do has to be reliable, safe, and economical. We have to put risk and progress into appropriate perspective. We need to look at what we can learn from what happened in the past. One of the lessons learned is the importance of heavy lift. Work in space is hard, risky, time consuming, and

expensive and should be avoided. Heavy lift reduces cost, risks, and time for large space missions. Heavy lift (multiples of EELV payload capacity) is needed. A combination of STS and EELV elements can provide heavy lift capabilities that can grow and evolve. Starcraft Boosters has a solution—the Aquila Heavy Lift. It builds on the present STS, uses Evolved Expendable Launch Vehicle (EELV) engines, minimizes ground infrastructure modifications, and could be ready for flight by 2009. Mr. Aldrin showed evolutionary options and variations. With respect to the CEV, we must consider the long term and not take the expedient, near term design solutions. The CEV will evolve. The capsule used for Apollo was expedient, but had disadvantages. Mr. Aldrin showed a proposed CEV designed for use on multiple launch vehicles and crew module evolution. He noted the experience level of Starcraft Boosters, Inc. It has an expertise and credibility that should be brought to bear in the Code T deliberations, e.g., independent assessment. Mr. Aldrin expressed his excitement about the various ways of supporting Moon operations. There are multitudes of transportation systems that could be used. The most challenging aspect is sustaining the mission. We need about eight four-year election cycles. Mr. Aldrin stated that he stands willing to help and work with people in planning for the future.

Mr. Aldridge asked Mr. Aldrin to give his perspective on whether NASA is organized to carry this program out. Mr. Aldrin stated that NASA has vacillated back and forth between strong Headquarters and strong Centers. The competition between the two major centers during the Apollo era was unfortunate, and it continues. The program needs central organization, and it is coming along with Code T (Exploration Systems).

In response to a request from Dr. Tyson to compare and contrast public sentiment during Apollo with that today, Mr. Aldrin noted that the Apollo days were pioneering days—everything was new and fresh, and the immediate results were amazing. As industry matures, it becomes more difficult. It is difficult to recreate the excitement and sustain interest on long-term missions. Along with the exploration program, we need another excitement-driven program that has people involved in it. There are things that we could do, but it must involve the public and have role models beyond career astronauts.

In response to a comment from Gen. Lyles on the goals and whether a Space Vision Institute is still needed, Mr. Aldrin noted that his expertise is in the arena of how to get things done. However, we need to be careful not to over promise. With respect to Mr. Walker's comments on the idea of picking the next crew early to focus public interest and build personality in the program, Mr. Aldrin observed that how to train a crew on such an extensive mission will be a challenge. Mars should be a commitment to growing permanence or we should not do it. The other extreme would be a selection at the last minute. Mr. Aldrin suggested using James Cameron and his projection of winning and entertainment to advise NASA. Mr. Aldrin opined that we might have made lunar exploration look too easy. Apollo had a great team and everyone was inspired. There are some tough choices. There is something powerful about the people who reach lunar distance, and we should make some meaningful use of that group.

After the lunch break, the first afternoon panel was “Commercial Space and Economic Feasibility.” Speakers included Mr. Michael Kearney, President and CEO of Spacehab, Inc.;

Mr. Marco Caceres, Senior Analyst and Director of Space Studies, The Teal Group; and Mr. Stephen Fleming, General Partner, EGI Ventures.

Mr. Kearney provided a brief history of Spacehab, Inc., and focused his remarks on issues and opportunities for space commerce. Government and commercial cultures differ, and both have experienced issues. NASA has found Spacehab's services to be of high value, but this commercial approach has proven problematic for at least two reasons: (1) a value-based price for commercial fixed price services is difficult to establish in the government's contracting structure; and (2) the nature of space flight operations has created necessary price adjustments when the government has been unable to launch within the parameters of the fixed price contract. The uncertainty in the market inhibits a strong business case. For space commerce to thrive, there must be regularly scheduled commercial transportation and access for business customers that is not subject to government priorities. Two inhibitors to market investment exist. (1) The government has been reluctant to purchase commercial space services at market price when there has not been a demonstrated proof that a market with two or more suppliers exists. Without that, private investors cannot expect returns greater than 15%. (2) Industry has been reluctant to invest in commercial services for an emerging market without a strong government customer. These two inhibitors are related. Both the government and industry want regularly scheduled, competitively priced and affordable transportation to orbit. Once operational, such a service would resolve the current limitations of the fledging LEO market and initiate private investment. The new U.S. Space Exploration Policy sets aside budget to initiate these services from emerging launch systems. Space commercialization must move from the practices of public administration to the practices and institutions that govern commercial activity: private ownership and operation of assets for private benefit; pricing based on a value that is established by the market; and investment based on entrepreneurial risk-taking and meriting a substantial return. Mr. Kearney highlighted several recommendations. NASA needs to choose to buy commercial services from two or more suppliers. Government should play the same role in space commerce that it plays in terrestrial commerce—it should maintain infrastructure and regulate commerce. It should fund research and pioneer leading edge technologies, and then transition them to the private sector. Mr. Kearney provided background material and contended that a commercial solution for providing transportation and logistics services to the Space Station is available today. This expertise can also be applied to lunar and Mars activities.

Mr. Caceres spoke on the subject of maintaining public support for long-term space initiatives. He conceded that initially, he had doubts about the exploration initiative being affordable. However, whenever a company or agency announces a new satellite or launch vehicle, analysts will include it in our calculations of what we believe will happen in the future. He cited the Teledesic constellation as a program in which few openly voiced much confidence. Ultimately, it went nowhere. However, Teledesic was taken seriously by analysts because they could see the day when it might be completed. From either a business or political standpoint, it is unreasonable to expect to hold the attention of supporters, audience, or consumers for much more than a decade. There has to be some sense of urgency or clear purpose attached to multi-billion dollar programs or else they lose the public's attention and confidence. The Bush Administration and many within the industry would like to recreate the enthusiasm and spirit of the Apollo era by laying out a bold vision to return to the Moon by 2020 and then moving on to Mars and beyond years after that. However, Kennedy's vision was a short-term one. It would

not have had the same impact if it had been stretched out over 20 or 30 years. The average person cannot see that far ahead or does not want to. Mr. Caceres discussed the Space Station and how we should learn from it. We are 20 years into the program and are still 2 to 3 years away from final assembly. The Space Station did not capture the enthusiasm of Apollo. Space was still a new frontier in the 1960s and we were in competition with the Soviets. In addition, the Space Station program has taken too long. The good news about the Space Station is that it is an excellent model of how not to do a major space program. In order to stay focused, the program must have a clear starting point and a clear ending point, and the closer those two points are, the greater the success. The within 10 years timeline is a good place for NASA to start. The Moon/Mars efforts must be clearly defined and marketed on their own merits, starting with the Moon. Mr. Caceres advised “de-linking” the two missions. He stated that it is fine to have a broad plan to send manned missions to the Moon and then to Mars, but if they are linked, the public will suffer from “information-overload” and eventually tire of hearing about a grand scheme that will take 20 to 30 years to achieve. The challenge of “selling” the Moon-Mars separately should be easier than holding the public’s attention through 3 decades and at least eight presidential administrations.

Mr. Fleming discussed the role of private investment in space exploration. Manned spaceflight is still a monopoly of government. There is minimal interest from Wall Street. Why? Mr. Fleming cited that history of the railroads, the automobile industry, and aviation. The government partnered with railroad companies to make sure the railroads were built. The government paved the roads, but entrepreneurs were able to find private investment to build cars. Government was a huge customer for military and civilian aviation, but it didn’t build cars. Until the 1960’s, it was assumed space would follow the same pattern as the railroad, auto industry, and airlines. However, private industry never fully engaged. We still have never seen a privately funded manned spaceflight. In the 1960s, we said, “it’s different this time.” What Kennedy stated did not attract Wall Street—long term, dangerous, expensive. We went to the Moon too early and never went back. The ISS goals are primarily political. There is minimal to zero interest from industry. Now, the President has proposed to go back to the Moon and to Mars. This will probably be extraordinarily expensive. We are a wealthy country and can afford it, but what are we going to do with it? We need to transform the American economy. Flags and footprints still make a lousy business plan. The Commission has two decisions: how to minimize costs to the taxpayers, and how to use this initiative to break out of the old space concept. We need a series of steppingstones that build a lasting infrastructure where people can make money. The cost of access to space is the single greatest barrier to space exploration. Costs are too high. High launch costs will doom us to repeating “flags and footprints” missions and this is wrong. We know how to fix this problem. There are a dozen of entrepreneurs that could lower launch costs. The barriers are economic and political, not technical. Investors are comfortable taking technology risk; they are not comfortable taking market or regulatory risk. Through this Commission, the government can reduce those risks by reducing market and regulatory risks. The Government should act like a customer. Issue contracts that provide guarantees; minimize regulatory risk. Entrepreneurs can and will use these contracts to raise money from Wall Street. Profitable industries are sustainable; government programs are not. With a private launch industry, missions to the moon and Mars will become much cheaper. It’s time for private industry to take over the job of getting to low earth orbit (LEO).

In response to comments from Mr. Aldridge, Mr. Kearney noted that if you allow the space access business to be driven by industry, you would get investment. In response to the question—What can the Commission do to make this happen?—Mr. Fleming proposed that the government say that any launch will be competed on the public market and those launches will be available to any commercial vendor who can prove that they can do those launches. Mr. Kearney observed that there has to be enough revenue to generate the margins to pay back the investment. You could reduce the number of times that the Shuttle has to fly to Station by moving cargo off the Shuttle. Astrotech has a commercial facility for telecommunications for the EELV market better than anything at NASA and the Air Force. NASA is now coming to Astrotech.

In response to a question from Ms. Fiorina on why the first contract to Spacehab was let, Mr. Kearney stated that there were people at NASA who were motivated to help develop the space-based economy and stimulate a commercial activity in space. At the time, this was visionary. Government contracting regulations and procedures are very complex and inhibit the development of commerce. NASA needs to transport to the Space Station without the Space Shuttle. The industry has four alternate access contractors that are offering ways to get to Space Station.

Mr. Tyson commented that even if NASA is enthusiastic, if there are not other customers, how could it be possible? Mr. Fleming agreed that we need the government to be the first customer, the “anchor” tenant. Volume will drive the price down. The demand curve is elastic. Mr. Kearney added that Spacehab sells to non-NASA customers to do research in space. There is a backlog of international researchers that have an interest in flying. There is a market out there. How much in addition to NASA will depend on other factors.

Dr. Spudis noted that it is different this time. The President specifically mentioned learning to use space resources. This initiative is not just a Moon or Mars mission, but is a mission to change the paradigm. Fundamentally, we are mass limited to what we can do in space. This is an opportunity to change that rule. Resources on the Moon and Mars can be used to create new opportunities. ✓

In response to a question from Mr. Walker, Mr. Kearney stated that companies could be prepared to begin delivering goods to the Station on the order of 30 to 36 months, certainly before the gap of 2010 to 2014. Mr. Fleming added that he thought that it could be done for \$5 billion. Prizes do not make a business plan, but they stimulate technology.

Ms. Fiorina summarized testimony heard today: the vision to go to Moon, Mars and beyond is bold, and we should approach this bold goal with focus and a sense of urgency. We need to approach it with the full set of resources, including the entrepreneurial capability. In addition, the mission should be bolder. It should transform the American economy and the American worker. Mr. Fleming agreed. This could be a step similar to how the railroads were built, and it could transform our culture. Mr. Caceres observed that we would have to do something bolder than just exploration. The kind of things that excited youth back in the Apollo days doesn't excite them now. Mr. Kearney suggested that we allow the free market mechanisms to work. The space program draws things from outstanding people. In this country, people feel the ability

do anything they can envision as worthwhile. That can drive a whole string of jobs. For airmail, the government was the only customer—there were no passengers. Then the government allowed passengers to fly along with the mail. This was the start of air travel.

Mr. Jackson asked the panelists what the full tool kit would look like if we were going to do business in a different model. There are elements of the vision that cannot be off-laid to the private sector. The launching of the enterprise is the hardest. The tool kit can include getting the private sector into the market. States are trying to do economic development to make it attractive to business. There could be a role for prizes. How do you jump-start the first six or eight people? Should we be getting help internationally and how would that work? Mr. Fleming noted that there is a lot that can be learned from DoD. DARPA has worked very well. The Federal Acquisition Regulations (FAR) are incredibly hostile to startup companies. The DARPA model could go a long way. Mr. Kearney agreed that there is a way. There are two parts of the FAR. Part 12 is the commercial part. You can essentially waive all of the requirements and buy from the commercial market. The first and foremost in the business case issue is the market—how many will you be able to sell? The first step is creating a consistent, stable, predictable market. You could allow advertising. Mr. Fleming agreed that NASA should be able to advertise. Young people see ads for the Army, the Marines. Why not NASA?

Mr. Aldridge introduced the last panel of the day—the “Media Panel,” with Mr. Daniel Stone, President and CEO of Space Holdings; Mr. Gary Robbins, Orange County Register; and Mr. John Copeland.

Mr. Stone and Mr. Robbins gave their perspective on public attitudes. Mr. Stone cited several problems. One of the obstacles is NASA’s seeming inability to excite and engage the public. He discussed the challenges and presented some recommendations. Kids are born with a natural interest in space. NASA needs to excite the public and invigorate its workforce with new talent—it needs a “womb-to-tomb” marketing strategy. NASA needs to enter the universe of marketing. Marketing works, e.g., the U.S. Army. “Outreach” by its nature does not inspire. NASA needs to sing its praises through satellite technology. Companies such as Hewlett Packard and Disney understand the attraction of space and use space to market their products. Why can’t NASA use the power of space to evoke space? There were two significant newsworthy events in the last year: Columbia, and landing of the Mars rovers. Sustainability in the public consciousness, the popular culture, is key to the sustainability of the program. NASA has felt itself constrained from delivering a marketing message. NASA must advertise for “recruits” and the support of its vision. Whatever prohibitions NASA has need to be lifted. Many astronauts work in relative obscurity. NASA needs to market these people as national heroes. The vision has a “cool” factor, and NASA should be a cool place to work doing cool things. Mr. Stone gave the Commission the following recommendations: (1) NASA needs to explicitly embrace marketing and invest behind it; (2) solicit the advice and counsel of professional marketing firms; and (3) work with established brands and public/private partnerships to reach its audience.

Mr. Robbins addressed the question: What makes a long-term program of interest to the public? Everyone involved needs to look at how to deal with the issues associated with the pace of life today—it is much faster and people’s attention spans are shorter. Grabbing and holding attention

is difficult and getting harder because people are bombarded with information. Everyone is competing for attention. Mr. Robbins suggested a couple of solutions. (1) NASA needs to do a better job of conveying what it is to live and work in space—put the human back into human space exploration. Astronauts are fascinating people—e.g., put Mike Foale on David Letterman. Venues are very important. People relate to people. (2) Have the type of lunar rover that could stir interest, e.g., with a camera for high-speed images in real time. Public interest in images from a rover is potentially huge, e.g., the Mars rovers. People have to participate on some vicarious level in order to keep them interested. In addition, the emphasis needs to be on media technology. Think of how to reach people. Look outside NASA for answers.

Mr. Copeland added that content and marketing are important. It would be worthwhile if NASA were to spend more time to provide good multimedia coverage of their efforts in space. When we go back to the Moon and to Mars, there should be an opportunity for people to go along in a virtual presence and participate in activities. Robotic exploration can accomplish a lot. Get virtual participation in the robotic missions, and then have real people following them.

Gen. Lyles noted that until about 5 years ago, the Air Force did no advertising. It started marketing when it got to a crisis stage and could not reach its recruiting goals. There is a tremendous message about NASA, and it needs to get out. Mr. Stone commented that NASA is at a crisis stage—there will not be many chances to capture people's interest. Many events are coinciding now, and that make this a special time. The NASA website is the second most active website, and is probably the most popular. There is a disconnect between this and knowledge about NASA. It will require marketing and this requires money, but it is a good investment. Mr. Robbins noted that the public was promised science on Space Station, but there is not a lot going on. If you are going to market, what are you going to do? People are holding back to see if it is real, if the money will come, if there will be a program that makes sense. One thing should lead to the next. Mr. Copeland added that NASA could help to lead young people into science and mathematics. It can help the pipeline of people going into these fields, and this will benefit the U.S. economy. Most of the people in graduate schools are coming from other countries.

In response to a question from Dr. Zuber on whether there would be a place in the Orange County Register to do “weather on Mars,” Mr. Robbins stated absolutely. However, the data must exist in a form that can be used. We need to also change the culture of academia. The media spends a lot of time trying to “decode” what people are saying. We need to talk in plain terms. If the community isn't speaking in a clear voice, it is hard to get it into the newspaper.

Dr. Tyson asked about the line between marketing something that people will feel good about, and something that people feel has to be “sold.” Mr. Stone noted that it has to be somewhere in the middle—between what is good for people and what they want to digest. There is some arrogance in the community about deciding what is good for people. It needs to be packaged in a way that is “consumable.” However, it should not take away from the credibility of the underlying information. Mr. Robbins added that JPL has an extraordinary public relations staff. They get you to the scientists that can explain it in lay terms. In response to a question about the public interest between space (missions, hardware, people) and space as scientific discovery, Mr. Stone indicated that the baseline traffic and consumer interest is on astronomy and scientific

missions. This has been true for the Mars rovers (exploration and science brought together). Space exploration, astronomy, and science need to be brought together. Mr. Robbins noted that if you get the information out there in a way that is compelling, people are interested. People are interested in science, but the public literacy rate in science is very low.

The last half hour of the hearing was devoted to Audience Comments:

David Christensen: The challenge for the Commission is absorbing all of the information and putting that into a compact, straightforward document.

Earl Babbitt, Georgia Tech: Back in the mid 70s a lot of former aerospace engineering students around campus left the program because the space program was not continuing to inspire. Some maintained the vision, and these are the people that can lead us. America needs to encourage the development of space, to inspire young people and encourage the vision of those already inspired. I hope that America doesn't waste the potential. Please help us develop an enduring vision.

Richard Silvan: In 1986, many of the same things that occurred are occurring now. NASA needs continued oversight by a panel to keep it on the straight and narrow. It will change form, but will have a tendency to go back to a bureaucratic nature. Constantly bring new people in, get new ideas. NASA needs a broader base—a broader technological base and a broader idea base. The Mars Society is developing rovers with the University of Michigan. NASA should ask young people to develop ideas, with very little money. This would bring people in with new ideas. Increase the population base. It takes NASA to make space boring. Space is not boring. Get physicians in the evaluation program of radiation risk.

Erin Armenitos: I hope that the Commission will take a look at the education system. The current one stifles innovation. People need to be free of fear of making mistakes. There is more than one solution to a problem. Use the resource of the National Consortium to do for space what the Consortium did for Earth.

Jed Ready: Many Americans feel malaise about the space program. We need a focal leader, a torchbearer, and a person with an eloquent tongue, someone that will not wither from criticism. Many speak of the large costs, but many of the nay-sayers don't realize that the cost to the taxpayer is less than a penny out of every dollar. Hold our attention beyond the 5-second soundbite. Rekindle the American frontier spirit. Commence immediately, not in 120 days.

David Hill: Respond to announcement of Mercury 7 and today. Many people meet the requirements in the astronaut corps. We need to bring them to the public. Go to Hollywood and look at the headline names. Every one of them has an agent who is responsible for getting them public appearances and cameo roles. NASA needs an agent to get the people before the public.

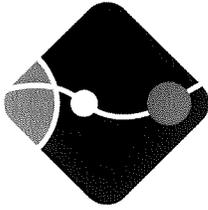
Ronald Minish: Near Earth objects (NEOs) and burnt out comets approach Earth closer than others in the asteroid belt. Today, there are about 2717 known NEO's and scientists estimate that there are as many as 100,000 or more out there. This is a new phenomenon that the public doesn't understand or the exploration potential that is there or how easy these object are to get to,

compared to Mars. Image the new vistas that could be presented to the public—good high quality images from an asteroid. There are some real possibilities in exploration of NEOs. Dr. Tyson noted that during the summer of the tandem of Hollywood movies on this subject, the public interest did not stick around. It has been unappreciated and poorly recognized. Mr. Minish noted that high quality color images are what people love.

Randy Evera: Very few Americans understand where the charter of NASA is located in the public law-Chapter 42 of the public health and welfare code. From what we have heard about entrepreneurial business and government partnering, we need to overhaul the NASA charter and bring it into currency and relevance. We need heavy lift capability. We will not be in the game without it. Propulsion research and development is vital. We need to find out what we should know—cryogenic, chemical, nuclear, electrical, etc. We need to restore the total belief that the American people own NASA—it is their space agency. We can't just depend on the President, Congress, or the Commission. It has to be the will of the people. Mr. Evera offered my support.

Grant Turpin: There are 63 countries and 3 million people that hit the NASA website. That is less than the population of Georgia. Where are those people today? Why aren't they here? It goes to marketing and media coverage. There has been not one single report on the local news about this hearing. If this is going to be a multi-decade program, you must have solid public support behind the program. This generates political support.

Mr. Aldridge thanked the participants for their comments. He adjourned the meeting at 3:35 p.m. A press conference with the Commission followed the hearing.



President's Commission on Moon, Mars and Beyond

WITNESS LIST AND TIMELINE FOR ATLANTA, GEORGIA, HEARING

*Hearings will take place at the Georgia Center for Advanced
Telecommunications Technology
250 14th Street NW, Atlanta, Georgia 30318*

Wednesday, March 24, 2004

- 1:00 – 1:15 p.m. Welcome and Introductions
Chairman Pete Aldridge
- 1:15 – 2:00 p.m. Space Entrepreneurs
Mr. Elon Musk, Founder, Zip2 and PayPal

Dr. Peter Diamandis, Chair & CEO, ZeroGravity Corp.

Mr. Jeff Greason, XCOR Aerospace
- 2:00 – 2:15 p.m. BREAK
- 2:15 – 3:00 p.m. Georgia Institute of Technology
Dr. Narayanan Komerath, Professor of School Aerospace Engineering
- Field of Research: Developing Space-based Economy

Mr. Daniel Hegeman, Student, Aerospace Engineering
- Student government representative and research member of
“Mars Desert Research Station”

Dr. Paul Ohme, Director, Center for Education Integrating Science,
Mathematics, and Computing
- 3:00 – 4:00 p.m. Developing Public/Private Partnerships
CAPT Winston Scott, (USN, retired) Executive Director, Florida Space
Authority

Mr. John Hager, Homeland Defense, Virginia

Mr. Tim Huddleston, Executive Director, Aerospace States Association
- 4:00 p.m. Commission adjourns

Thursday, March 25, 2004

- 9:00 - 9:15 a.m. Welcoming Remarks
Chairman Pete Aldridge
- 9:15 – 10:00 a.m. Building Space Jobs
Dr. Michael Balzano, Executive Director, National Industrial Base
Workforce Coalition
- Mr. Charlie Bofferding, Council of Engineering and Scientists
- Mr. Jeff Rainey, Business Representative of District 166,
International Association of Machinists and Aerospace Workers
- 10:00 – 10:45 a.m. Lessons Learned Regarding Managing a “System of Systems”
Mr. Gary Payton, Deputy for Advanced Systems
Missile Defense Agency
- 10:45 – 11:00 a.m. BREAK
- 11:00 – 11:45 a.m. National Research Council Report: “Safe on Mars”
Mr. Frederick H. Hauck, President & CEO, AXA Space
- Professor Harry Y. McSween, Jr., University of Tennessee
- Dr. Ronald E. Turner, Principal Physicist, ANSER Corporation
- 11:45 a.m. – 12:15 p.m. Mr. Buzz Aldrin, Apollo 11 Astronaut
- 12:15 – 1:15 p.m. LUNCH
- 1:15 – 2:00 Commercial Space & Economic Feasibility
Mr. Michael E. Kearney, President & CEO, Spacehab, Inc.
- Mr. Marco H. Caceres, Senior Analyst & Director Space Studies
The Teal Group
- Mr. Stephen Fleming, EGL Ventures
- 2:00 – 2:15 p.m. BREAK
- 2:15 – 3:00 p.m. Media Panel
Mr. Daniel Stone, President & CEO, Space Holdings (Space.com,
Space News, Starry Night)
Mr. Miles O’Brien, CNN
Mr. Gary Robbins, Orange County Register
- Mr. Scott Heiferman, Meetups (invited)

Thursday, March 25, 2004 (con't.)

3:00 – 3:30 p.m. Audience Comments

3:45 – 4:30 p.m. Press Conference

4:30 p.m. Hearing adjourns

President's Commission on Implementation of United States Space Exploration Policy
Washington, DC
February 11, 2004

COMMISSIONERS

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

Carleton S. Fiorina of California

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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
Georgia Center for Advanced Telecommunications Technology
Atlanta, Georgia
March 24-25, 2004

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Osburg, Dr. Jan	Georgia Tech/Mars Society
Kubota, Yuko	Japan Aerospace Exploration Agency
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Garza, Lucas	AE student
Armenios, Brian	AE/GT
Sylvan, Richard	MS
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Babbitt, Earl	Self
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Sebastian, John	Grad student - AE
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Prakash, Ravi	Grad student - AE
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Viney, Geoff	Self
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