



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

**Washington, DC
February 11, 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
Chairman**

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Introductory Comments

Mr. Pete Aldridge, Chairman of the President's Commission on Implementation of U.S. Space Exploration Policy, welcomed attendees to the Commission's first Public Hearing. He introduced Ms. Susan Flowers, Public Affairs Officer, and noted that material on the Commission (the charter, the background of Commissioners) is available on the web site: www.moontomars.org. The web site also is a location where people may provide comments to the Commission. Each of the inputs will be reviewed and forwarded to the Commission as appropriate. Mr. Aldridge stated that the President has asked the Commission to chart the course for a successful journey to the moon, Mars, and beyond. The Commission is not here to challenge or debate the President's Vision.

Mr. Aldridge introduced the Commissioners:

- Dr. Laurie Leshin, director of Arizona State University's Center for Meteorite Studies and the Dee and John Whiteman Dean's Distinguished Professor of Geological Sciences at the University. Her research 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 Lester Lyles (USAF ret.), former commander of the Air Force Materiel Command. 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. He was the deputy leader of the science team for the Clementine lunar mission.
- 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. He served on the Future of the US Aerospace Industry Commission in 2001.
- The Honorable Robert Walker, chairman and chief executive officer of The Wexler & Walker Public Policy Associates, a firm specializing in telecommunications and technology issues. Walker 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.

Commissioners not present at this hearing were:

- Dr. Michael P. Jackson, senior vice president for AECOM Technology Corporation. Dr. Jackson is the former U.S. Department of Transportation Deputy Secretary.
- Ms. Carleton Fiorina, chairwoman and chief executive officer of Hewlett Packard.

Mr. Aldridge briefly commented on his background. He is a former Under Secretary for Acquisition, Technology and Logistics in the Department of Defense and previous served as Under Secretary and then Secretary of the Air Force under President Reagan. He was chief executive officer of The Aerospace Corporation, a non-profit organization dedicated to solving critical national problems through science and technology, and president of McDonnell Douglas Electronic Systems Company.

Mr. Steven Schmidt is the Commission's Executive Director and the Designated Federal Official.

Mr. Aldridge noted that the Executive Order for the Commission was signed on February 3, 2004, to provide recommendations on implementation of the President's Vision. Specifically, he asked for the following: a science research agenda; technologies, demonstrations, and strategies that could be used for sustainable human and robotic exploration; criteria to select future destinations for human exploration; long-term organization options for managing space exploration activities; roles for the private sector and international participation; methods to encourage youth in science, mathematics, and engineering; and management of implementation of the policy within available resources. Mr. Aldridge emphasized that the key elements for success are sustainability and affordability.

The Commission held its first administrative meeting on February 9. It has 120 days to produce a report. There will be several more public meetings around the country to hear from organizations and individuals. The Commission's customers are the President and the American people. The hearings will be seeking comment on the implementation plan. Four themes appear to be emerging: science and technology; education and youth; management process and sustainability; and competitiveness and prosperity for the benefit of Americans and all mankind.

Testimony: Ray Ernst, Chairman of the Aerospace Industries Association (AIA) Space Council

AIA represents the entire aerospace industry infrastructure. Its member companies constitute almost 95% of the aerospace industry. AIA thinks the President's Vision is exactly what NASA and the country need to maintain leadership, and is delighted with the initiative. It extends far into the future and pulls many programs together with a new goal. It provides measurable goals and leadership. There has been a clear definition of funding from NASA, and it has been mapped out. It is achievable and affordable. In addition, it will excite students and bring the necessary qualified talent into the government and industry. It will sustain the workforce at large and strengthen the industrial base. The AIA is looking forward to joining in the program. Mr. Ernst reviewed what the AIA has been doing over the past several years. In the mid-2002 timeframe, AIA energized its group of companies and came forward with some recommendations and plans for the infrastructure of the Shuttle and the Space Station, identified critical issues, and examined how industry could get on board. It recognized the need for a roadmap and measurable goals, with industry participation. These activities were fully supported by the President's initiative. Other generic initiatives included discussion on increasing the space science and technology budgets, concern with industrial workforce and base, and recommendations on some stronger procurement strategies. In 2003, AIA outlined two activities: the top ten issues for 2004, one of which focused on developing a strategy for the next generation of human space flight; and 2004 election issues, one of which was replacing the Shuttle with a modern human space transportation system. These two initiatives are in the President's plan.

Mr. Ernst offered some areas for consideration, the first of which was to emphasize U.S. capabilities and utilize the investment in U.S. assets. If international participation is encouraged, ensure the partners bring adequate investment. There are enormous investments in U.S. space assets and the Shuttle infrastructure as a whole. Look first to U.S. assets for the transportation requirements. The emphasis and balance related to robotic and human missions should be maintained. In addition, other Enterprises at NASA are important, i.e., Earth Science and Aeronautics. Lastly, NASA and the government can benefit from cooperation with other government agencies, with respect to leveraging technology and infrastructure areas.

In conclusion, Mr. Ernst restated that the AIA is delighted and believes that this is what the country needs for a long-term endeavor. It requires long-term vision, long-term funding, and long-term development. This will help the industry to align its investment to meet the needs of the nation. It will inspire students and public support.

In response to a question from Mr. Aldridge, Mr. Ernst stated that the AIA has not yet looked at any unique management ideas that would make this project sustainable over the long term. However, the AIA would welcome the insertion of industry in this discussion. The AIA has been talking with Congress and NASA to have industry involved in the level 0 and 1 requirements to make both technical and management recommendations. Mr. Aldridge encouraged development of these ideas at future AIA meetings, and

indicated that the Commission would welcome them. Mr. Ernst took an action to do this. He indicated that he could energize activity at the highest levels of the member companies to make these kinds of recommendations.

Gen. Lyles asked whether the AIA saw any gaps that have not been addressed by the Vision. Mr. Ernst indicated that there were no glaring omissions. The AIA plans to put in a position paper on the Space Transportation Policy and help with the update/rewrite of the plan. Gen. Lyles added that short- and long- term goals and a roadmap would be useful to the Commission. Mr. Bruce Mahone from the AIA took an action to provide a copy of this to the Commission.

Mr. Walker noted that one of the problems is the long-term aspect, in terms of sustaining funding. He asked if the AIA would be prepared, over a period of 15-20 years, to keep the kind of focus that the President is demanding. Mr. Ernst stated that the AIA would be delighted with this kind of focus. It will take cooperative leadership among government, industry, and academia. There will be many opportunities for reviews and course corrections as architectures are understood. It will take strong leadership and AIA is delighted to be on board to support the Vision. Mr. Walker agreed that the AIA could be a good instrument to keep that focus over a number of years, and welcomed AIA's plans to continue to develop the constituency.

Dr. Tyson asked Mr. Ernst to comment broadly on the relative value between legacy management and the experience from systems engineering vs. the next generation of engineers that might enter the workforce. Is AIA inclined to go back to the laid off/retired set, or reinvent what is necessary, or a combination? How will the personnel issue be managed? Mr. Ernst indicated that the AIA currently has a well-trained and energized workforce. What has been lacking is what excites students to go into engineering fields. The industrial base is there, and there will be a balance of experience and new talent. We can get back to the excitement that was there in the 1960's and 1970's. Mr. Aldridge commented that hopefully, there will be an incentive for students to enter the science and engineering fields to sustain the base. AIA is trying to energize the youth through several means, e.g., the rocket launch contest.

Dr. Zuber asked about other NASA missions (Earth Science and Aeronautics) and whether AIA sees these as part of the Vision, or a parallel path. Mr. Ernst observed that Earth Science and Aeronautics were not directly part of the Vision. However, the synergism between the Enterprises does underpin the necessary science, and it needs to continue. In response to a question from Dr. Leshin, Mr. Mahone noted that AIA can gather information on lessons learned from the government/industry partnership. In the programmatic area, each company deals with the government. However, knowing the timeframe, the AIA can get with its members to provide suggestions. Mr. Ernst agreed to expedite the action and try to get something to the Commission within the next 30 days or so.

Gen. Lyles noted that the Vision will also be dependent on industry's commitment. It is important to get a feel for the numbers associated with IR&D, and whether there is a

commitment to increase these numbers in the future, and in what areas. Mr. Ernst stated that AIA would take an action to gather information from its members on what commitments or investments in IR&D are being made. Leverage of technologies is a better answer than duplicating actions.

Mr. Aldridge noted that industry has to deal with multiple customers and often has a better understanding of application of technologies to multiple missions. When polling industry on the technology questions, he suggested having industry identify technologies in DoD that might be applicable to the President's Vision. Mr. Ernst indicated that he would ask for the companies to provide these types of comments and recommendations, but would probably get response at the top levels, due to the proprietary nature of IR&D technology. Mr. Aldridge indicated that the Commission would be particularly interested in enabling technologies, e.g., those that would make a difference in achieving the mission, such as life support. With respect to incentives, Mr. Ernst noted that this is very positive step in the NASA budget. Mr. Walker commented that he would be particularly interested in getting feedback on the "Centennial Challenges" program.

Testimony: Mark Bitterman, Chairman of the U.S. Chamber of Commerce, Space Enterprise Council (SEC)

The SEC, a vital component of the U.S. Chamber of Commerce, strongly supports the President's Vision for space exploration. It is uniquely qualified to address space from the perspective of the full spectrum of American industry. The space program over the last 40 years has yielded significant economic benefits. Benefits of space reach into homes, schools, and businesses. The lesson of history outside the space sector is that exploration has yielded economic growth. This growth has impacted a large segment of industries outside the aerospace sector, including the medical, computer, and public safety fields. Attraction of students into science and engineering has strengthened the U.S. workforce. NASA's investment in space represents 15% of the expenditure in space. Commercial investment in satellites represents the largest segment. Implementation of the President's policy must be in the context of worldwide space activity. The full range of American business must be mobilized in the space goals. Strong allies and coalitions will be essential for success. There will be no room for the parochialism of a "NASA-centric" approach. Successful implementation of the Vision will largely be the responsibility of U.S. industry. Mr. Bitterman emphasized that the SEC stands ready to assist the Commission.

Mr. Aldridge noted that sustainability is one of the key issues. Every year, through the budget process, and every 4 years through the election process, there must be a way to convince the public and Congress to sustain the program. What is the mechanism for sustainability? Mr. Bitterman suggested that the Commission try to understand the five billion web site "hits" since the Mars rover landing. Clearly, there is excitement. Once new discoveries become real possibilities and are discussed in schools, kids get excited. This will matter. Dr. Tyson noted that increments in perceived cost bring on another kind of debate that goes beyond a successful mission. The space enterprise feeds our economy, not only through direct spinoff, but in attracting students to become scientists

and engineers. Whether or not they go into the space industry, they go into some industry and become intellectual capital. The public does not understand the actual impact of space on their lives, and the right kind of information is not reaching them. The low Earth orbit benefits are easier to communicate. Beyond that, it becomes more challenging. What can be done to get this out to the public? Mr. Bitterman noted that the creation of the SEC was in recognition of the importance of space by the Chamber of Commerce. It took a long time to get this recognition, but it is there now and is growing. A lot of cynicism has developed about the application of space. If people grasp that this is an exciting journey where we cannot predict what we will get, and that we will learn more about this planet through exploration of space, then that will help with the support.

In response to a question, Mr. Bitterman indicated that the SEC is more in the promotion business, rather than tracking economic impact. It tries to articulate why space is relevant to the upper management levels in the Chamber of Commerce. Mr. Walker observed that none of this seems to get reflected in Wall Street. He asked whether the SEC could help the Commission understand how to leverage investment beyond what the government will be making. Mr. Bitterman noted that the SEC is on this task. It will be building membership with financial institutions, and can help put this picture together.

In response to a question from Mr. Aldridge regarding a Presidential office, Mr. Bitterman observed that there must be sustained advocacy for what the President said in January. There is expectation in Congress and in industry that the White House still has to be “on point” as this initiative goes forward. NASA is a great agency, but cannot do it on its own. It cannot carry the entire advocacy load. There was a Space Council in the White House for a number of years, and it was very useful. In the years since its dissolution, there has been difficulty in getting policy passed on space matters. A reestablishment of the Space Council within the Office of the President would be a very effective way of sustaining advocacy across administrations. Mr. Aldridge added that any ideas on a mechanism for interagency interaction at a high level of leadership, or any other ideas on the sustainment issue would be very helpful to the Commission. Mr. Bitterman took this as an SEC action.

Dr. Zuber noted that many things would contribute to the success of the endeavor. She asked Mr. Bitterman to comment on what kind of timeframe these things would need to know that we are on the right track. Mr. Bitterman cited the success of the Mars rover mission. These should not be discrete events—they should be tied to what we are trying to do later. Gaps are very dangerous. Hollywood could have a large role to play, and the space community should be able to partner in some way with Hollywood.

Mr. Bitterman submitted a written statement and Mr. Donahue’s letter for the record.

Testimony: Norman Augustine, Chair of the Advisory Committee on the Future of the U.S. Space Program

Mr. Augustine discussed the findings of the Advisory Committee, which was established 14 years ago. He noted that a great deal has changed since the Committee conducted its

work. There is no longer a Soviet Union with a strong space program that provided a major impetus for the U.S. space program. China has emerged as a major space participant. The U.S. never realized the 10% annual growth in the space budget that was forecast at the time of the Committee. Rather, the NASA budget continued to decline in real terms. The commercial space business has been reduced to a commodity marketplace and has been a major disappointment. The U.S. space industrial base has shrunk from a large number of healthy companies to only a few companies with space credentials. There still seems to be no truly broad consensus on what the long-term goals of America's space program should be. On the other hand, a great deal has not changed. This Commission meets on the heels of a tragic failure (Columbia) as did the Committee (Challenger). There continues to be strong grass-roots support, but this is not evidencing itself in terms of budget impact. There remain strong budgetary demands for activities other than space to meet the needs of the nation, e.g., the war on terror. The number of U.S. citizens studying engineering has continued to decline. America's K-12 educational system remains in extremis, especially in the areas of science and technology, although the space program seems to inspire young people, more than anything else, in science and technology. There is continuing concern over the apparent loss of much innovativeness and management acumen in NASA, but it nevertheless remains the world's finest space organization. Clearly, the NASA of today is not the NASA of the Apollo era. The public and even parts of NASA have come to accept space activities as relatively routine and taken for granted. Finally, the Chair of the Commission has also come under criticism as having conflicts of interest, just as Mr. Augustine did.

Many of the Committee's recommendations are still relevant to the Commission's work today:

1. NASA was badly overcommitted in terms of goals and funding. The Space Station and the Shuttle were major consumers of funding, and cost overruns had major impacts. A primary concern was the lack of adequate reserves in terms of money, schedule, technical alternatives, and personnel.
2. There seemed to be a lack of national consensus on a specific goal for the space program. The Committee believed that it would be inappropriate to set a firm date for some particular goal given the prevailing budgetary circumstances. Rather, it thought that it was important to first build a firm, technological undertaking and to conduct a program on a "go as you pay" basis.
3. America's space program should be balanced, involving humans and robotic elements. The Committee believed that public support for the overall space program would diminish if there wasn't a human element.
4. Science should be the first priority of America's civil space program.
5. There should be a mission to planet Earth as well as from planet Earth.

6. Space transportation was the primary impediment to conducting a healthy space program. Humans in space should have a value-added role. The Committee recommended that steps be taken to mitigate dependence on the Space Shuttle.
7. Develop a new, unmanned heavy launch vehicle (and build no additional Shuttles).
8. Operation of Space Shuttle should not be viewed as routine, e.g., like operating an airline. The Shuttle is more akin to an advanced form of an R&D program.
9. The Committee believed that it was only a matter of when, not if, we would lose another Shuttle. Reliability estimates were grossly optimistic. Space is inherently dangerous and risky and is unforgiving of human failings.
10. There was a need to proceed with dispatch in the development of some form of rescue vehicle and a need to continue to operate the Space Station in the absence of the Shuttle.
11. The Space Station program needed to be restructured to place it on a more conservative schedule and more realistic financial basis, and adequate reserves needed to be provided.
12. A human trip to Mars would be the correct long-term goal for the space program, using the moon as a stepping stone along the way. Missions to other space objects would be candidates for the more distant future.
13. NASA's management and engineering approach needed to be reengineered. Various Centers were often engaged in non-constructive competition.

Mr. Augustine concluded his remarks by offering four observations of a more personal nature:

1. If NASA is to have a robust space program, we must build a national consensus as to what that program should comprise. The sustained support of consecutive administrations and Congresses will be needed. This argues for a program that can be accomplished step-wise, with significant achievements along the way, with the final time scale somewhat open-ended.
2. Tangible benefits are not sufficient in themselves to justify the cost of the undertaking. One has to assign value to intangibles—excitement of exploring the unknown, creating new knowledge, inspiring young people, stimulating science and engineering education, etc.
3. It would be a grave mistake to undertake a major new space objective “on the cheap.” This is an invitation to disaster. There is a tendency in any “can-do”

organization to believe that it can operate with almost any budget. Space activity is difficult and expensive.

4. One day humans will go to Mars. The only questions are when and who.

Mr. Aldridge commented that the members of the Augustine Committee were visionaries. He noted that concerns have been expressed about the mission to planet Earth under the new Vision. Mr. Augustine observed that the mission to planet Earth is continuing. It has reasonable health. The important thing is that it not suffer as we take on the mission from planet Earth. The President needed to address the mission from planet Earth because it is the area of greatest confusion and is the area of greatest financial impact.

In response to a question from Dr. Tyson regarding the budget, Mr. Augustine noted that the Apollo program was a \$100 billion undertaking. Of course, \$150 billion is a huge sum of money, but there are enormous running costs within NASA—operating all of the Centers, Station, and Shuttle. While some of these costs can be reduced over time, it will be over a long time. Also, there are other demands in NASA's budget, e.g., aeronautics. To begin the program without ample reserves is a mistake. We have traditionally underestimated costs. Mr. Augustine indicated that he was concerned with undertaking this program on the timeframe called out within the current budget. He indicated that he had not done enough analysis to be confident of a definite answer, but he would bet that the proposed budget wouldn't be enough.

In response to a question from Gen. Lyles regarding the characteristics of the NASA of the Apollo era vs. the NASA of now, Mr. Augustine noted that the most obvious difference is that the people in the command center were young, innovative, imaginative people. NASA is aging, and this is a concern. There is great value to experience, but there is also great value to not accepting the status quo. The NASA personnel structure needs to be addressed to induce young people to apply to the Agency. Also, NASA's procedures and overhead structures have grown. When taken collectively, it is hard to change course and takes a lot of energy. Also, in terms of systems engineering, NASA is probably not as strong as it should be. The government's hiring rules tend to discourage dedicated, competent people from serving in government. Mr. Aldridge noted that a new personnel system was enacted for NASA within the past couple of weeks—a pay for performance plan for civil servants and a reduction of the "red tape" on hiring and transfer within the Agency. This should help rejuvenate NASA for the President's Vision. Mr. Augustine advised the Commission to watch carefully how it is implemented, and Mr. Aldridge agreed that it is important that the new system be implemented properly. With respect to the budget, the President has challenged the Commission to look at what it would take to achieve the Vision in a sustainable and affordable way. His plan has laid out a 5% annual increase. Dates are goals, not firm milestones. It is a pay-as-you-go plan. Mr. Augustine commented that the risk of setting firm dates is that people do whatever they can to be there by that date, and that can lead to problems.

Mr. Walker asked whether there are areas where NASA shouldn't be managing the programs anymore and they should go somewhere else. Mr. Augustine stated that the Committee did look at that, e.g., whether NOAA should have a bigger role. The NASA aeronautics program is an important part that is often overlooked. A lot of NASA's budget is relatively fixed, given its overall structure. Additional funding will be required, and adequate reserves are necessary. Mr. Walker remarked that some of the Centers would not fit precisely within the President's Vision, and questioned whether they might be happier somewhere else. Mr. Augustine noted that at the time of his study, there was a lot of overlap among Centers. Also, NASA Headquarters was less strong than it is today. When the Space Station was started, every Center tried to carve out its piece. No Center likes to be left out. This will be a challenge for NASA management. Project managers are probably the most critical, under-available resource in the engineering world. Good ones are hard to find. This could prove to be a greater limitation than money. Mr. Aldridge indicated that he shared Mr. Augustine's view that there are not enough systems engineers in the business. NASA will need to focus on systems engineering skills to make all of the pieces fit together.

In response to a question from Dr. Leshin regarding risk, Mr. Augustine stated that we need to better communicate the risks of the program, and that the benefits are worthy of the risk. We also need to take steps to diminish that risk. However, it will never be zero—that also needs to be communicated. Given the experience of the ISS and Shuttle and the Soviets experience, we should be able to do better. The Institute of Medicine (IOM) indicated that America loses 50,000-100,000 people a year to medical mistakes. Yet we move on and continue to do better.

Dr. Zuber commented that the implementation will be facilitated if there is a sensible roadmap. One of the results of the Augustine report was that going to the moon was a way station. Many have asked the question: What does that buy you? What is the value of going to the moon as a way station? Mr. Augustine noted that the Committee did consider direct missions to Mars. It also concluded if there was just a mission to the moon, it wouldn't build great national support. However, if it is portrayed as a sensible step in going to Mars, it is a sound engineering conclusion—it provides a means of operating on another planetary body, a chance to get real experience operating remotely, a chance to exploit materials on the moon to support the next step, and other useful things related to exploration and observations. It makes more sense to go to the moon first, then to Mars. The timeframe depends on funding. It would be hard to inspire people for a goal in 2025 without any intermediate step.

Dr. Tyson observed that this Commission exists because something failed in the aftermath of the Augustine Committee. He questioned why the report was not adopted by the public. Mr. Augustine asserted that sustained Presidential leadership is most important, and that was missing. Second, the NASA budget didn't evolve the way that it was anticipated. There was a loss of faith in NASA as an organizational entity. At the same time, there were huge demands during the 1990's. Mr. Augustine cautioned that if the public is skeptical when you start out, then don't. In response to a question from Mr. Aldridge, Mr. Augustine agreed that a Space Council is needed. The Committee

recommended strengthening the National Space Council. Its purpose was to provide policy guidance and ensure that resources were available. It got into trouble when it tried to get into operations; however, the Council is extremely valuable if constituted as a policy oversight body. Mr. Aldridge observed that there could be a lot of leverage with other agencies, but there is not a way for NASA to tap into those agencies without something like a Space Council.

As a final remark, Dr. Tyson commented that with the profile of NASA and the scientific community today, he is hopeful that the next generation will use the full enfranchisement of what America is today.

Testimony: Gen. Tom Stafford (USAF, ret.), “America at the Threshold”

Gen. Stafford provided his views on the Vision. He reviewed the history of the previous studies initiated by the Space Council on the future direction of the space program, beginning in 1989. Stafford’s Committee on the Space Exploration Initiative (SEI) developed a number of recommendations and several architectures. The architectures were: Mars exploration; Science Emphasis for the Moon and Mars; the Moon to Stay and Mars Exploration; and Space Resource Utilization. The first architecture option included the moon as a first step for testing and verification. The science emphasis required more resources. All architectures had a common theme of exploration and science, human presence, and resource development. In response to a question, Gen. Stafford noted that the first option is similar to the current Vision.

General Stafford reviewed the recommendations on the SEI. Management was one of the key issues, and the first four recommendations relate to it—the need for a long-range strategic plan, the need for a National Program Office, the NASA Associate Administrator as Program Director, and an aggressive acquisition strategy for SEI (streamlined acquisition management). To carry out a program of this magnitude, it cannot be business as usual. Streamlined acquisition management is essential. SEI requirements also incorporated a heavy lift program. Stafford’s group recommended 150 – 250 metric tons to low Earth orbit. Miniaturization has advanced in terms of payloads, so less lift into low earth orbit (LEO) would be required today. It became obvious that nuclear thermal rocket technology development was the only way to go to Mars. To do adequate *in situ* work on the moon and Mars, space-based electric nuclear power is necessary. Gen. Stafford commended Mr. O’Keefe on NASA’s nuclear initiative. He noted that after the propulsion issue is handled, the biggest risk going to Mars is radiation. Stafford’s group also recognized the need for focused life science experiments. Closed life support experiments have been run at Johnson Space Center (JSC). A motivational factor is essential, and education should be a principal theme of exploration. Stafford’s group also recommended an expanded outreach program.

Gen. Stafford noted that the long-range strategic plan is now going forward. A National Program Office should be staffed by NASA, DoD, and DOE. As international partners are brought in, this Office would be the one to pull the international involvement together. This Commission could give a lot of guidance to NASA with respect to a

streamlined acquisition strategy. As noted earlier, NASA has started a nuclear initiative. The space nuclear power initiative needs to be focused and have adequate attention from management. The long pole in the tent is the nuclear thermal rocket. Also, lightweight pressure suits are needed. This was ongoing, but the program was cut back.

To achieve the SEI, the technology priorities were:

1. heavy lift launch capability
2. nuclear thermal propulsion
3. nuclear electric surface power to megawatt levels
4. extravehicular activity suit
5. cryogenic transfer and long-term storage
6. automated rendezvous and docking of large masses
7. radiation effects and shielding
8. telerobotics
9. closed-loop life support systems
10. human factors for long-duration space missions
11. lightweight structural materials and fabrication
12. nuclear electric propulsion for follow-on cargo missions
13. *in situ* resource evaluation and processing

Many of these technologies are currently being pursued.

The group put together a list of space experience legacies—what worked and what didn't work on Gemini and Apollo. The resulting guidelines were:

1. Establish crew safety as the number one priority
2. Have clear lines of management authority and responsibility for all elements of the program.
3. Ensure that one organization or prime contractor is clearly in charge.

4. Establish realistic program milestones that provide clear entry and exit criteria for the decision process and create useful capabilities at each step.
5. Ensure that the Administration and Congress clearly understand the technical and programmatic risks and realistic costs of the SEI.
6. Mandate simple interfaces between subsystems and modules
7. Make maximum use of modularity over the life of the program to maintain flexibility. Successive missions should build on the capabilities established by prior ones. Provide the capability to incorporate new technology as required.
8. Press the state of the art in technology when required and/or when technological opportunities are promising—with acceptable risk
9. Ensure optimum use of man in the loop. Don't burden man if a machine can do it as well or better, and vice versa.
10. Limit development time to no more than 10 years. If it takes longer, the cost goes up and commitment goes down.
11. Focus technology development toward programmatic needs.
12. Minimize or eliminate on-orbit assembly requiring extravehicular activity.
13. Minimize mass to LEO to reduce cost.
14. Have redundant primary and separate backup systems. Design in redundancy versus heavy reliance on onboard onsite maintenance.
15. Hire good people, then trust them (don't micromanage)

Some of the pitfalls identified by the Stafford group were:

1. Establishing requirements that are really “wish lists” and allowing “requirements creep.”
2. Trying to achieve a constituency by promising too much to too many and “low-balling” the technical and financial risks.
3. Committing to interminable studies and demonstrations.
4. Not establishing configuration controls and baselines as soon as possible.
5. Allowing software to run unchecked and become a program constraint rather than a supporting element.

6. Setting up agreements for development of program elements that are not under direct program management control.
7. Not saying “we were wrong” when we were wrong.

Since 1991, some efforts have been completed toward going back to the moon and Mars, e.g., a closed-loop study and a “transhab” information package and prototype.

Gen. Stafford agreed that nuclear thermal propulsion was an enabling technology for a Mars mission, with savings of billions of dollars and drastically reducing liftoff weight.

In response to a question regarding the EVA suit, Gen. Stafford indicated that there needs to be a lot of development in this area. Pressure suits need to be lighter in weight and more flexible. This effort was underway and was cancelled, but for a relatively small expenditure of money and adequate development, improvement in suits can be achieved.

Gen. Lyles commented that he was struck by the list of supporting technologies. He noted that with the exception of the EVA suit, all of the technologies on the list are technologies that other agencies, e.g., the Air Force, are developing to some extent or another. NASA should leverage this technology effort.

With respect to NASA management, Gen. Stafford was asked to give some comments on the reorganization that NASA is currently making at Headquarters to address some of the things that the study talked about. Gen. Stafford indicated that he knew only some of the primary details, but would be glad to look into it.

In response to a question from Mr. Walker on a nuclear thermal rocket, Mr. Stafford indicated that he would try to come back to the Commission with a report on it. We had this in the late 1970’s. It is an enabling technology for Mars. To go back to moon, chemical propulsion is adequate. There could be two or three dockings in orbit, but not assembly in orbit. Mr. Walker observed that the issue with the nuclear rocket will be political. Gen. Stafford stated that a nuclear rocket can be perfectly safe; it will not be radioactive until turned on in orbit.

Dr. Zuber asked Gen. Stafford to comment on the idea of “acceptable risk.” He noted that going back to Apollo, crew safety was .9999; mission safety was .90. The program needs to be up in at least the 98-99% range in crew safety.

In response to a question from Dr. Tyson regarding technology, Gen. Stafford observed that we should only put technology on when it is specifically required to accomplish a mission. We need to take a good hard look at the resources vis-à-vis the existing infrastructure, both pluses and negatives. A National Program Office should take a hard look at requirements and what they should really be. In terms of development time, 10 years is the outer limit, and that would apply to the nuclear thermal part. We could have some demonstrations to get back to the moon using some existing capabilities. Mr. Walker agreed that the program would need to meet a series of shorter goals.

Mr. Aldridge noted that the Commission must address sustainability. He also asked about leadership. Gen. Stafford observed that the basic vision starts with the President. We have the opportunity this time. Previously, we had a change of administration, and the vision got zeroed out. It must be supported by the Executive branch of the government. Mr. Aldridge agreed that this is a long-term program and must be bipartisan. The American people need to take ownership of it. They need to be the stakeholders. Gen. Stafford agreed, and added that another emphasis has to be education.

Testimony: Cort Durocher, Executive Director of the American Institute of Aeronautics and Astronautics (AIAA)

Mr. Durocher briefly reviewed the background and history of the AIAA. Its mission is to advance the arts, sciences, and technology of aerospace. It has 35,000 professional and student members, 50 corporate members, and 100 professional staff. Currently, the AIAA has an active role in the U.S./India space cooperation endeavor. The AIAA applauds the space exploration Vision outlined by the President. This program is important as part of a balanced aeronautics and space program. However, we should not miss the chance to get the whole world together in taking the next step. The U.S. should encourage private sector involvement in areas such as launch systems and services, communications, operations support, and new technology development. The U.S. should also encourage international participation in this Vision. Other countries have expanded interests and capabilities that could be combined with those of the U.S., and we should actively encourage other countries to join in and play significant roles. Other countries wanting to play major roles must also be prepared to commit and assure availability of commensurate resources.

Mr. Durocher discussed the benefits of international cooperation: enriching the scientific and technological character of the initiative; making the initiative more affordable; adding robustness and redundancy; providing access to launch sites, facilities, and other capabilities; and increasing the global political legitimacy of the venture. The potential challenges include forging long-term commitments that survive changing conditions and resolving export, non-proliferation, and competitiveness issues.

AIAA sponsors international conferences and workshops, and invites the Commission to participate in them. There have been six International Space Cooperation Workshops to date. These workshops have provided opportunities for leaders from the U.S. and other countries to discuss a wide variety of space program and policy issues. Mr. Durocher presented some information on the past six workshops. The first workshop was "Learning From the Past—Planning for the Future," held in Hawaii in December 1992. There were about 60 people from 15 different countries. Topics were space science, space exploration, space applications, supporting infrastructure, and international cooperation. At the second workshop, the participants looked more in depth at the "how." The third workshop was in Europe, and topics included the criteria for international space cooperation, using space assets for disaster management, international cooperation in space transportation, and Space Station utilization strategy. Mr. Aldridge noted that the criteria for international cooperation would be of particular interest to the

Commission, and that he would like to put that report in reference library. Mr. Durocher indicated that the seventh workshop, to be held in May in Alaska, will take a look at that area again.

The fourth workshop was in Canada, and looked at government and industry relationships. The fifth workshop, in Bermuda, was on solving global problems. The sixth, held in Spain, covered space traffic management, global navigation, and the contribution that space systems make to multilateral environmental agreements.

Mr. Durocher reviewed the criteria for international cooperation, which will be revisited at the next workshop, "From Challenges to Solutions." Mr. Aldridge asked if the AIAA could take a quick look at the President's Vision and the criteria and provide some input to the Commission. Specifically, he asked the AIAA to comment on what it might see as logical areas of cooperation that fit the criteria. Mr. Durocher indicated that he would be happy to run the President's Vision with the existing criteria as a test case.

In response to a question from Gen. Lyles on things that could be addressed in AIAA programs or other areas to stimulate students, Mr. Durocher noted that what is needed is a compelling Vision and program to get people excited. The AIAA has a number of programs for students. This Vision could be the "lightning rod" for increased interest. Mr. Aldridge noted that the AIAA's "Evolution of Flight" program was a very successful lightning rod for students. This Vision is a next logical step for a series of stimulating topics, and the AIAA should think about using it.

Dr. Tyson remarked that on the moon there is an American flag, which is a point of pride for all Americans. Most people would not argue against international cooperation. However, he asked Mr. Durocher to comment on the nationalistic flavor that space travel has as part of its baggage. The space program remains a point of pride in America. It may be that there is more money to "do it alone" than there would be in a partnership, where there is a dilution of the American dimension of the plan. Mr. Durocher observed that we cannot force another country to be part of this initiative. There is an assumption that if we are willing to have them others join us, they would be willing to do so. ESA has put forward an Aurora program, which is essentially very similar to the President's Vision—it involves the moon, humans, and robotics, and the timeframe is not too inconsistent. Theoretically, ESA might be willing to come forward. We could do this without international participation, but the question is—should we? The AIAA believes that the total value of the program would increase if we had significant and appropriate international participation. Mr. Aldridge noted that the program has to be laid out under the assumption that it will be U.S. alone, but if people want to come join us, the criteria for international participation would be most useful. In response to a question from Dr. Leshin, Mr. Durocher indicated that if the Space Station had been matched against the criteria for international cooperation, it would have passed the test.

Mr. Aldridge adjourned the Public Hearing at 2:35 pm. He announced that there would be a press conference for credentialed media at 3:30 p.m.



Agenda

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

Wednesday, February 11, 2004

0900 – 0910	Welcome	Pete Aldridge, Chairman
0910 – 0930	Introduction President's Vision Executive Order Charter Processes Schedules	Pete Aldridge, Chairman
0930 – 1015	Testimony	Raymond A. Ernst AIA Space Council Chair
1015 – 1100	Testimony	Mark E. Bitterman U.S. Chamber of Commerce Space Enterprise Council
1100 – 1200	Testimony	Norm Augustine Report of the Advisory Committee on the Future of The U.S. Space Program
1200 - 1300	LUNCH BREAK	
1300 – 1400	Testimony	Lt Gen Thomas Stafford (Ret.) America at the Threshold
1400 – 1500	Testimony	Cort Durocher American Institute of Aeronautics and Astronautics
1500 – 1510	Closing Remarks	Pete Aldridge, Chairman
1515 – 1600	Press Conference	Credentialed media only
1600	Adjourn	

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
Washington, DC
February 11, 2004

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