

The Politics of Space Economics

Mary Lynne Dittmar, Ph.D.*
Dittmar Associates, Houston, TX 77586

In January of 2004, President of the United States George W. Bush introduced “A Renewed Spirit of Discovery: The President’s Vision for U.S. Space Exploration”. European, Canadian, Asian and Russian responses have varied widely. Internal to the United States, public reaction has been mixed. One factor underlying the caution demonstrated by virtually all respondents is the issue of cost; such an effort is beyond the resources of a single country and will require international cooperation, i.e., investment. The second factor is the difficulty of “ensuring sustainability” through multiple U.S. Administration and Congressional shifts. This paper briefly reviews the history of human space flight in light of the factors which have driven expenditures in the past and posits that the current initiative may fail unless one of the following conditions is met: (1) The emergence of a political imperative sufficient to spur international governments to reprogram funds while garnering cross-generational public support, or (2) the development and implementation of a economic model that enables cost-sharing among international governments, private industry, commercial interests and the public to a degree previously unprecedented in human space flight. The paper concludes with some high-level requirements for a cost model necessary to meet the second condition, a speculative discussion of the type of “transformational event” to meet the first, and some suggestions for approaching the issue of program sustainability.

I. Introduction

THE Vision for Space Exploration proposed by President Bush in January 2004 calls for humans to return to the Moon, establish a presence there, and use the capabilities developed on the lunar surface as a stepping-off point for further exploration of the Solar System, with Mars as the initial destination. Specific milestones include the launch of robotic missions to the lunar surface by 2008, human arrival on the Moon between 2015 and 2020, and the execution of a human Mars mission sometime thereafter. As noted in NASA’s roadmap for the Vision for Space Exploration (VSE) published in February 2004¹, a number of technical and programmatic challenges are inherent in such a far-flung enterprise. None is more critical in both the short and long-term than the question of sustainability. Succinctly put, how can a program of the Vision’s size and scope be promoted, funded, developed, matured and maintained over a time span of 30 to 40 years, at minimum?

To date, the answer is not forthcoming. In the United States, the VSE has engendered a good deal of political skepticism from a Congress that is apparently not yet convinced of NASA’s ability to manage a program of such duration and complexity. Political debate will and should continue. However, unless a majority political coalition of some type can be forged, the Vision may die in Congress. No single argument or approach is likely to succeed. A well-planned approach that is flexible enough over time to respond to changes in the political and economic environment is needed.

One view of the problem reduces the VSE to two, interrelated top-level requirements vis-à-vis sustainability:

- 1) Ensure a sufficient level of public interest and political will to sustain the program across 30-40 years, and
- 2) Ensure sufficient funding to sustain the program across the same time span.

This paper explores some of the issues associated with funding and cost-sharing, beginning with a summary of international responses to the President’s space policy announcement of January 14, 2004². It will then briefly

* Owner/Senior Consultant, Dittmar Associates, 422 Crestwood Drive, Seabrook, TX 77586, AIAA Member

discuss the challenges of creating and maintaining the economic basis and public/political will necessary to sustain such an ambitious endeavor.

II. The Challenge of Sustainability

The history of human space flight has been chronicled extensively and will not be repeated here.^{3,4} A brief mention of the origins of human space flight is instructive, however, as it is relevant to the first “sustainability requirement” above. Indeed, sustainability was not generally debated in a public forum during the early years of space flight. In the late 1950’s and early 1960’s, a political imperative existed in the United States and the Soviet Union. The governments of both countries were deeply invested in a contest that pitted scientific, military, economic and ideological goals against each other. One manifestation of the contest was realized in the objective of putting human beings on the Moon. Eventually, the space-related goals of the two countries diverged and then partially converged again as part of a larger international cooperative effort which became the International Space Station (ISS). In spite of its achievements, the ISS program unfortunately has been notable for lack of public awareness in the United States, and political support has seesawed. Subsequent to the demise of the Cold War, no political imperative has filled the role of the “space race” to spur political and public enthusiasm and will.

A behaviorally-based restatement of the second sustainability requirement above might be: “Ensure a sufficient level of engagement of the political process in national (U.S.) and international arenas so as to acquire and maintain appropriate funding for the VSE across its duration.” Put in this way, and in the absence of a clear political driver, this goal can be seen as a “marketing problem” of significant complexity. Coupled with modest proposals for increases in NASA yearly budgets at a time of deficit spending in the United States, the relative lack of public engagement in the Vision has resulted in skepticism regarding its viability in some political circles.

A. Political Response in the United States

In the United States, the question of sustainability has been linked to program cost in political commentary both for and against the VSE, with affordability and sustainability often treated as equivalents.^{5,6,7} Anticipating the debate, the Bush Administration appointed a Commission chartered by NASA – eventually known as the Aldridge Commission after its Chair Edward C. “Pete” Aldridge – and tasked it to do the following:

“...provide recommendations to the President on the implementation of the vision outlined in the President’s policy statement entitled “A Renewed Spirit of Discovery” and the President’s Budget Submission for Fiscal Year 2005.”⁸

The specific tasks the Commission was instructed to address included providing guidance for the direction of scientific efforts and how to develop technologies to be utilized in the effort; identifying criteria for selection of human destinations off of Earth; making organizational and management recommendations; and identifying methods for leveraging the program to encourage education in science, technology, and engineering. Of particular note is the last in the list of tasks assigned to the Commission. Specifically, the commission was charged with providing recommendations as to “Management of the implementation of the Policy within available resources.”⁹

The wording of this task makes clear the rules that governed the Commission with regard to the issue of cost: The implementation of the Policy would be done under the terms of the President’s 2005 budget proposal and the Commission’s role was to identify how. This effectively closed off debate regarding other options. The result was a virtual omission of specific recommendations regarding budgeting – thus avoiding intensification (or suggestions for resolution) of the cost debate. Instead, the Commission offered an endorsement for a “Pay as You Go” approach, citing the cure for cancer as an example. This argument attempts to assert the *value* of Space Exploration (which is discussed throughout the report) as self-evident and positive enough in impact to society-at-large that acceptance of the VSE should follow – and with it, public and political acceptance of the “Pay as You Go” approach. While this method of managing expenditures may have merit, the approach emerged as an exercise in circular reasoning: First, endorse the Policy, then assert its value, then justify expenditures in the context of that value, then endorse the Policy. As a result, the justification for the funding model presented by the Commission may be convincing only to those who are already convinced.

In fact, it has been suggested that the Aldridge Commission Report has in it “a little something for everyone”.¹⁰ While a review is beyond the scope or intent of this paper, the report does become somewhat more specific in advocating a restructuring of the economic rules that have governed NASA’s procurements, and to some extent its politics, over the past 30 years. For example, it encourages the elimination of “cost-plus” contract structures in favor of technology demonstration and subsequent award (traditionally a DoD approach), greater private industry investment, and the establishment of a true commercial space industry, presumably both to advance economic growth in the larger sense and to provide a basis for cost-sharing. However, response to the Commission Report has been mixed, and in general it appears to have done little to alter the political debate or to disentangle the issues of cost and overall sustainability.

B. Political Response in the International Community

During NASA's "Industry Day" roll-out of the Exploration Enterprise (the program itself is referred to as "Project Constellation") in mid-June, 2004, a question was raised about international participation. The answer at that time was that the agency was reviewing international cooperation. Since then, NASA has indicated that international participation is welcome. The Aldridge Commission was somewhat more definitive, calling for extensive international cooperation in order to make the VSE a reality. This is as far as the report goes, however, as no model for cooperation was advanced. As in the United States, international political and public response to the VSE has covered a wide range.

In Europe, the Director General of the European Space Agency (ESA) described the new Space policy as "very good news for the space sector and thus for ESA too".¹¹ Two years earlier, ESA had initiated the Aurora Programme, calling for human and robotic exploration of the Solar System and postulating a human Mars mission by 2025. Except for the timeline, the U.S. and European programs are similar in development and goals, and Mr. Dordain added that ESA had already been studying related technologies and looked forward to collaboration with the U.S. on a human mission to Mars. Since that time, ESA has not issued public statements on the subject. Private communications with the author from within ESA have suggested that reactions have varied within the agency from irritation with the Bush Administration for what was perceived as a unilateral usurping of the European programme to enthusiastic interest in and hope for the future development of – and investment in – space.

Russian response has varied as a function of time. The first response came from Nikolai Moiseyev, Deputy Director of the Rosaviakosmos space agency, and pointed to the proud history of the Russian space program. He indicated that the agency had been studying the possibilities of going to the Moon and Mars and hinted that Russia might include these projects in a new space programme to be announced before the end of the year.¹² Yuri Koptev, then Director General of Rosaviakosmos, was more negative in an interview with Reuters two weeks after the U.S. announcement and three days subsequent to a statement from President Vladimir Putin that the U.S. and Russia could work together on space exploration. Koptev expressed his belief that the U.S. Space policy was politically motivated and stated that the primary objective of both Russian and U.S. space programs should be the completion of the International Space Station.¹³ The following month, Russia announced that it was developing a new spacecraft that represented a major upgrade of the Soyuz that could also be used for a mission to Mars.¹⁴

Russia reorganized its space agency in March of 2004, with Rosaviakosmos split into two entities. Aviation was transferred to one agency, while space programs were placed in a new Federal Space Agency. Mr. Koptev was replaced by Colonel General Anatoly Perminov, who was previously in charge of Russia's military space program.¹⁵ In his first news conference at the end of June, 2004, General Perminov reiterated that the primary mission of the Federal Space Agency is to maintain the ISS and complete its assembly, and pointed out that Russia is now playing the dominant role in that program due to the grounding of the U.S. Shuttle fleet subsequent to the loss of Columbia. He made no direct reference to U.S. policy, but noted that "no nation can be self-sufficient in manned space exploration now".¹⁶

The Japanese government was circumspect, choosing not to issue an official response. The Director of the JAXA (Japanese Aerospace Exploration Agency) Office in Washington, D.C., noted that Japanese response was "not negative", but that the agency and government would await further developments. By contrast the Asahi Shimbun, Japan's most prominent newspaper, was not circumspect in its response, stating directly that "any unilateral approach under which the United States calls the shots and other countries are supposed to follow its lead will not work".¹⁷ Japan has had ambitious plans for solar system exploration for over a decade, culminating in its publication of a report entitled "Toward Creation of Space Age in the New Century" in 1994.¹⁸ That vision anticipated an international lunar base sometime after the year 2010, with Japan as a major participant. Since then, Japan has had an active space program in both human and robotic space flight, although recent spacecraft failures combined with the effort to reorganize its space efforts into a new entity (JAXA) have stalled progress.¹⁹

Marc Garneau, President of the Canadian Space Agency, was positive in his response to the Space Exploration announcement:

"I would like to see Canada be an active, visible participant in future missions to the Moon and Mars. With our track record of 40 years of achievement in space, Canada has proven its worth as a partner with key expertise to contribute to space missions and space science. Imagine where the future might lead us. Imagine the tantalizing possibility of a Canadian walking on the surface of a foreign world, and imagine what that might mean for our country."²⁰

Canada's recent election (June, 2004) resulted in the Liberal Party in power. In a survey conducted with the major political party by the Mars Society, the Liberal Party reiterated its support of the Canadian Space Agency. As of this writing, no government position regarding the U.S. space policy has been released outside of the space agency.

China's government issued an immediate response through its official news agency, Xinhua. Although generally positive, it too alluded to the notion of U.S. hegemony with regard to the Space Exploration policy advanced by the Bush Administration:

"China is willing to cooperate with countries in the field of aerospace and peaceful exploration of outer space on a friendly and equal footing. The Chinese is positive and open in this regard."²¹.

Other countries also provided responses: India (positive), Brazil (positive), United Arab Emirates (mixed), Germany (mixed).²²

III. Considerations for Cost-Sharing

It should be stressed that no single approach will be successful at achieving sustained political interest and funding levels. While endorsing "Pay as You Go", the Aldridge Commission also acknowledged the benefits of international participation, noting that:

"The vision provides the opportunity for significant participation for international partners. They bring *resources* [italics added] and expertise, government-to-government commitments contribute to stability and sustainability, and partnerships contribute to constructive dialog between nations."²³

International cooperation and financial participation is intrinsically a form of cost-sharing. That the international community is waiting to see if the VSE survives the 2004 Presidential election is understandable; however the careful nature of many of the responses suggest that governments are cautious about signing up for a plan that is clearly defined as advancing U.S. interests without an understanding of how it will advance their own. If the United States is to launch and sustain such an ambitious plan, it will need the participation of international partners and their business sectors. It will also need the contributions and participation of the U.S. private sector(s): Aerospace, new technology firms, small business and other entrepreneurs, and the exploitation of commercial ventures such as advertising. While some of these issues were addressed in the Aldridge Report, what follows are some specific suggestions regarding "high-level" requirements for garnering and sustaining these elements of a cost-sharing approach.

A. International Participation

Requirement: An international partnership shall be structured so as to best balance the political and financial interests of all partners.

Put bluntly, any country wishing to become involved in an Exploration of the Solar System program must be able to answer the question "What's in it for us?" The answer must reflect economic incentives – including short-term investment for the purposes of stimulating long-term growth – as well as balance national and regional agendas. The experience of the International Partners in the ISS Program has made many government and industry representatives extremely cautious about the prospect of entering into another long-term commitment with the United States, particularly when the nature of the relationships among participants in the new program is not yet defined. While it is conceivable that a program based on the assumption of U.S. hegemony rather than on equal partnerships can respond to a variety of government constituents, it appears from some official (and unofficial) statements to date that this assumption will be problematic.

B. Private Aerospace (and other) Industry

Requirement: Private industry investment and participation options shall be structured so as to provide for acceptable Return on Investment (ROI). This shall include a rethinking of Intellectual Property (IP) rights when substantial private investment is involved.

Large aerospace companies plan expenditures against returns. Long range operating plans drive most business planning, and investment is not undertaken unless markets for products and services are understood and definitized, generally over a 3-5 year business cycle (longer under some circumstances). Acceptable ROI can be achieved in a number of ways. For example, products developed partly or wholly on company money for one purpose (for example, Project Constellation) could be successfully marketed in other segments, assuming that IP rights are flexible and clear. Reduction in costs and an associated increase in financial margin can be achieved by methods such as tax incentives. Whatever the path forward, a business environment must be created that ensures the ability of aerospace companies to choose investment scenarios associated with acceptable returns.

C. Small Business

Requirement: Small business participation shall occur on the basis of innovation, technical achievement, and cost competitiveness, rather than through mechanisms such as subcontracting or set-asides.

“Cost-sharing” in the classical sense is not viable for small businesses. However, it is possible to vastly improve the cost-benefit ratio currently associated with the participation of Small Business involved in NASA efforts. Under the current model, the majority of small businesses associated with NASA (and other government agencies) are relegated to the role of subcontractor to the major aerospace companies. As such, their contributions are directed by and frequently limited to execution of specific tasking under the larger government contract. Yet, independent small businesses represent 99.7% of all employers, employ half of all private sector employees, generate 60 to 80% of net new jobs annually, and with regard to innovation produce 13 to 14 times more patents than large businesses.²⁴ Providing mechanisms for small business to “stand alone” and enter the Exploration Enterprise on the basis of innovation and technical achievement rather than on subcontracting has the potential for major benefits to NASA. This could begin through elimination of many of the flow-downs regarding financial reporting and accounting that are beyond the ability of most small businesses to manage.

D. Advertising

Requirement: Legislation shall be structured to enable NASA to raise funds through advertising and sponsorships so as to “cost-share” as a participant in the program.

In a footnote, the Aldridge Committee suggested that NASA consider advertising.²⁵ A comparison was made to the role of advertising and sponsorships in funding other “noble pursuits” such as the Olympics. This is not a new suggestion. Worldwide, corporate sponsorship revenues for the 2004 Summer Olympics are expected to reach \$1.7B (U.S.)²⁶. The Bush Administration proposal to fund the Vision for Space Exploration begins with an increase of \$1B distributed over 5 years (roughly \$200M/year). If NASA were able to achieve 60% of the Olympics sponsorship revenues the agency would match the President’s proposed budget increase from 2005-2009 - and this is but one form of “advertising”. National licensing of the NASA logo for qualifying business efforts, commercial advertising and appropriate “product placement” – all of which can be done in a tasteful manner – could generate significant funding for the program.

IV. Public Perception and Political Will

As mentioned earlier in this paper, the political imperative driving expenditures and efforts in the initial phases of human space flight had diminished even before the end of the Cold War. What, then, will generate the public and political interest that will sustain the program over several U.S. Presidential administrations and Congresses, and in the face of the shifting nature of international politics?

A. Whither A Politically Transformative Event?

A politically transformative event is one that brings about an immediate, significant shift in the nature of public and political discourse and perception. A recent and tragic example was the destruction of the World Trade Center in New York City on September 11, 2001. Of less international consequence, but arguably of greater relevance to the topic at hand, the loss of the space shuttle Columbia on February 1, 2003 has elevated public awareness of the space program in the United States and engendered significant political debate regarding NASA’s managerial capabilities among members of Congress.

Upon China’s October 2003 entrance into the small (3) league of nations that have initiated a human space flight program, there was some discussion as to whether a second “space race” would ensue^{27,28}. China’s achievements to date and their commitment to continuing their space program makes them potentially both a rival and a partner in space-based endeavors. However, the Chinese effort lacks the elements of fear and threat that marked the U.S.-Soviet Union space race, and the discussion soon fizzled out.

A second and potentially more potent candidate for political transformation regarding space is the discovery of past or present life on another planet. NASA’s announcement of the possibility of fossilized, microscopic life in Martian meteorite ALH84001 stirred significant controversy in scientific, political, philosophical and religious circles. However, it is impossible to predict whether or not such an event will occur, let alone the actual outcome of such a discovery and its impact on the politics and related economics of the Space Exploration (or similar) program.

In the absence of a politically transformative event, the sustainability of the Vision for Space Exploration will rest on the ability of NASA and its national and international partners to craft a public relations campaign that is continually updated and renewed in the face of shifting public and political trends. It should be stressed that no single approach will be successful at achieving sustained political interest and funding levels. Telling the story once will not be enough; it will have to be told over and over again across the decades, building upon anticipated successes of which NASA is demonstrably capable, while also demonstrating the organizational competency and accountability necessary to address the inevitable failures that will surely come.

Three examples of specific challenges facing the “marketing” of the VSE will be discussed briefly. Each description will be followed by strategies intended to address the obstacle, accompanied by a paragraph or two with ideas for implementing it.

B. Sustaining the Vision: Challenges, Strategies, and Ideas for Implementation

Challenge 1: The public and political sectors will have to wait years after committing money before any visible benefits accrue at various points in the program. Left unattended, this “lapse” may negatively impact public interest, dampen political enthusiasm, and jeopardize funding.

Strategy 1: Demonstrate early and highly visible mission success. Accelerate the robotic mission schedule; get rovers on the Moon as quickly as possible. Provide “hands-on” opportunities for the public during planning, development and mission execution via the Internet.

Implementation 1: The current roadmap calls for the first robotic mission to be launched in 2008. There are, however, other mission models that might enable faster implementation. The intense public interest in Mars rovers, demonstrated first by Pathfinder and again recently by the Spirit and Opportunity missions provides a clear “proof of concept” for valuable, successful mission opportunities that will engage the public. Leveraging this interest in creative ways may create interest in the broader program, particularly if specific linkages between daily Moon rover activities as the “building blocks” for human activities are presented early and often throughout the robotic missions via animations, “specials”, documentaries, etc. In addition, encouraging vicarious participation via carefully designed multi-user simulations over the internet may be particularly useful for engaging certain segments of the population.

Challenge 2: The increasing U.S. budget deficit that is co-occurring with the beginning of the Exploration programs may negatively impact appropriations. This is particularly challenging for programs that are “front loaded”, such as the Crew Exploration Vehicle (CEV) program.

Strategy 2: Using industry “best practices” for program budget, forecasting, and returns, demonstrate that money appropriated for NASA will yield a national “return on investment” (ROI), quantifiable in dollars. Publicize the results early and often. Update as the program continues.

Implementation 2: Preparation of a business case, such as used in industry, might focus on the following aspects (as examples):

- a) Increased tax revenues from the aerospace and commercial sectors, generated as a result of increased employment and productivity at both the individual and corporate levels;
- b) Increased economic/market development as a result of technical innovations associated with the program (use Apollo-era and subsequent data to support)

Challenge 3: The U.S. form of government provides for periodic elections with the potential to rotate politicians with varying ideologies, philosophies, and appropriations goals in and out of the House of Representatives, the Senate, and the Presidency at frequent intervals. This makes it difficult to sustain programs over time.

Strategy 3: Develop and maintain a national commitment to Exploration that supersedes the political process, or at least maintains a sufficient majority in Congress to guarantee sufficient funding across the lifespan of the program.

Implementation 3(a). Apply marketing expertise; i.e. treat the assessment of how to market to each successive Administration and shifts in Congress as a professional market analysis. Initially view the Presidency, Senate, and House of Representatives as three different segments of a “political market”. Identify market needs (“pulls”) and drivers (“push”). Map the relevant characteristics of each segment. Identify similarities and dissimilarities among the market segments. For example, a similar market need across each of the three segments may be to create jobs among constituencies and to be publicly identified as doing so (i.e., “get the credit”). One possible response would be to develop a clear “marketing strategy” to address that need. This strategy might be based initially on developing sector-based employment models on the basis of (a) historical programs such as Apollo, Shuttle and ISS, and (b) anticipated workforce/job skills requirements for Project Constellation. The resulting jobs profile could then be mapped to each Congressional district. The information could be published in popular magazines and government reports. For the Office of the President, publicize the anticipated national total of jobs created and the national/international economic/market increases associated with the program. Identify possible secondary markets resulting from new technologies and industries. Update the models continually, across the life of the program, and publicize widely.

Implementation 3(b). Identify current political issues, and consider how the programs at various stages of development might address those. For example, a major issue in the political landscape in 2004 is the issue of

outsourcing. How might the CEV program address or help outsourcing? Track political issues that can be addressed by the program across the lifespan of the effort. Note that there is of course a clear distinction between identifying and publicizing the manner in which a program or programs may address issues, and tailoring the program to do so. Recent history provides lessons learned regarding the inevitable consequences of driving the development of complex technical/operational programs in response to changes in the political winds.²⁹

Implementation 3(c). Encourage, develop and maintain constructive relationships between other government agencies with direct interest in the VSE. In addition to the obvious benefits that may accrue from cost-sharing, those agencies with broad public and private industry bases will help gain political buy-in.

V. Conclusion

Sustaining the VSE over a 30-40 years timeframe will require the development of a viable cost-sharing model which includes full participation of willing international partners, together with a well-coordinated public relations program that will remain in place for the lifespan of the Space Exploration program. The program will need to be continually refreshed and possibly reconstituted across 30-40 years in order to “keep current” with changes in the public, political, media, business, and educational environments. In addition, it should rely to the greatest extent possible upon professional market surveying and analysis techniques in order to acquire and make best use of data reflecting public and political issues. To the greatest extent possible, this effort or something like it should begin immediately. Of all the challenges facing the VSE, sustainability may be both the least understood and the most critical for the success of a new era in Space Exploration.

References

¹National Aeronautics and Space Administration (NASA), “The Vision for Space Exploration,” Washington, D.C., Feb. 2004.

²Bush, G. W. “A Renewed Spirit of Discovery”, January 14, 2004. Cited in NASA, “The Vision for Space Exploration”, Washington, D.C., Feb. 2004

³Heppenheimer, T. A., *Countdown: A History of Space Flight*, John Wiley & Sons, New York, 1997.

⁴McDougall, W. A., *The Heavens and the Earth: A Political History of the Space Age*, Basic Books, New York, 1985.

⁵Bademli, I., “GU Law Panel Discusses Bush Space Doctrine”, *The Hoya*, Feb. 20, 2004, Georgetown University.

⁶Gambrell, K., “Aide: Kerry Supports NASA But Not Bush Space Program,” *Aerospace Daily and Defense Report*, May 4, 2004.

⁷House Committee on Science, “Experts Support President’s Space Plan, But Call For Changes,” PR 108-202, Washington, D.C., March 10, 2004.

⁸President’s Commission on the Implementation of United States Space Exploration Policy, “A Journey to Innovate, Inspire, and Discover”, Government Printing Office (GPO), Washington, D.C., p. 52, June, 2004.

⁹*ibid*, p. 52

¹⁰Olson, T., “The Aldridge Report: It’s All About Execution”, *The Space Review*, July 5, 2004.

¹¹Dordain, J. J., “ESA’s DG Meets The Press”, ESA Press Release, January 15, 2004.

URL: http://www.esa.int/export/esaCP/SEMKEW374OD_Benefits_0.html [cited September 5, 2004]

¹²Moiseyev, N., in *Space Daily*, January 15, 2004. URL: <http://www.spacedaily.com/2004/040115162118.8ffpi9bk.html> [cited May 10, 2004]

¹³Koptev, Y., *Reuters News Service*, January 29, 2004.

URL: http://www.wired.com/news/technology/0,1282,62097,00.html?tw=wn_tophead_6 [cited July 8, 2004]

¹⁴Wade, M., “Kliper”. URL: <http://www.astronautix.com/craft/kliper.htm> [cited July 10, 2004]

¹⁵Smith, M. S., “Potential International Cooperation in NASA’s New Exploration Initiative,” Testimony to the Subcommittee on Science Technology and Space: Committee on Commerce, Science, and Transportation, U.S. Senate, April 27, 2004. URL: <http://commerce.senate.gov/pdf/smith042704.pdf> [cited July 8, 2004]

¹⁶Perminov, A., *RIA Novosti*, June 29, 2004.

¹⁷Pryke, I. “International Cooperation in the President’s Space Vision: A Non-U.S. Viewpoint”, *42nd Goddard Memorial Symposium*, Washington, D.C., p. 16, March, 2004.

¹⁸Nomura, T. “Japan’s New Long-Term Vision: Creating a Space Age in the New Century”, *Space Policy*, 11, 1995, pp. 9-17.

¹⁹Logsdon, J., “Japanese Space Program”, Testimony to the Committee on Commerce, Science and Transportation, U.S. Senate, April 27, 2004. URL: http://commerce.senate.gov/hearings/testimony.cfm?id=1165&wit_id3334 [cited July 3, 2004]

²⁰Pryke, I., “International Cooperation in the President’s Space Vision: A Non-U.S. Viewpoint”, *Goddard Memorial Symposium*, Washington, D.C., p.17, March, 2004.

²¹*ibid*

²²*ibid*, p. 18-19

²³President's Commission on the Implementation of United States Space Exploration Policy, "A Journey to Innovate, Inspire, and Discover", Government Printing Office (GPO), Washington, D.C., p. 34, June, 2004.

²⁴Small Business Administration, "The U.S. Small Business Administration FAQ", 2003. URL: <http://www.sba.gov> [cited May 14, 2004]

²⁵President's Commission on the Implementation of United States Space Exploration Policy, "A Journey to Innovate, Inspire, and Discover", Government Printing Office (GPO), Washington, D.C., p. 20, June, 2004.

²⁶Sports Venue, "2004 Olympic Games – XXVIII Olympiad, Athens, Greece", July 10, 2004.
URL: <http://www.sportsvenue-technology.com/projects/olympic2004/> [cited on July 10, 2004]

²⁷CNN, "Chinese Launch Could Signal New Space Race", October 14, 2003.
URL: <http://www.cnn.com/2003/TECH/space/10/14/space.race/> [cited on April 7, 2004]

²⁸Walker, R. S., "The Race Into Space," *The Washington Times*, May 28, 2003.

²⁹Columbia Accident Investigation Board, "Final Report, Volume 1". Government Printing Office (GPO), Washington, D.C., p. 22, August 2003. URL: http://www.caib.us/news/report/pdf/vol1/full/caib_report_volume1.pdf [cited June 1, 2004]