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Science in NASA's Vision for Space Exploration—*Summary*

SPACE STUDIES BOARD

Background

In January 2004, President Bush announced a new space policy directed at human and robotic exploration of space. The National Academies released a report at the same time that independently addressed many of the issues contained in the new policy. In June, the President's Commission on Implementation of United States Space Exploration Policy issued a report recommending that NASA ask the National Research Council (NRC) to reevaluate space science priorities to take advantage of the exploration vision. Congress in the FY2005 Omnibus Appropriation Bill also directed NASA to request the NRC's Space Studies Board to conduct a thorough review of the science NASA is proposing to undertake within the space exploration initiative. This report provides a partial response to those requests. In addition, separate NRC reviews will be carried out of strategic roadmaps that NASA is developing to implement the policy.

Findings and Recommendations

There is a strong synergism between science and exploration which enables science to be an integral part of NASA's space exploration vision. The appropriate science in a vibrant space program is nothing less than that science that will transform our understanding of the universe around us, and will in time transform us into a space-faring civilization that extends the human presence across the solar system. While the opportunities are rich, however, they are also limited by available resources, and the issue is not what to pursue so much as what to pursue first.

Guiding Principles. There are several guiding principles for making these choices.

- Exploration is the key step in the search for fundamental knowledge of the universe.
- Both robotic and human means should be used to fulfill scientific roles in the mission. When, where, and how they are used should depend on what best serves to advance intellectual understanding of the cosmos and our place in it and to lay the technical and cultural foundations for a space-faring civilization.
- The targets for exploration should include the Earth, solar system objects where humans might visit, the rest of the solar system, the Sun, and the universe beyond.
- The targets should offer the greatest opportunity to advance our understanding of how the universe works, who we are, where we come from, and our ultimate destiny.
- Preparation for long-duration human exploration missions should include research to resolve fundamental engineering and science challenges.

Strategic Planning—Overview. NASA has started a strategic planning activity built around 13 top-level agency objectives. These are comprehensive and have the potential to include all of the scientific topics that are appropriate to NASA's mission statement. Strategic planning, nevertheless, will require substantial thought and the involvement of a diverse scientific community.

The choice of NASA's top-level strategic objectives recognizes that each offers the opportunity to advance and to benefit from understanding the universe and that each is a worthy endeavor in a strong space exploration program. Exploration in this broad sense is the proper goal for NASA. **As planning roadmaps are developed, decisions about priorities among and within NASA's objectives should be made on the basis of the opportunities for greatest impact. Critical scientific and technical breakthroughs should be highlighted that are possible and in some cases necessary.**

Strategic Planning—Process. Over the years, the NRC has produced a number of reports that can contribute to the NASA strategic planning process. The first set, the most recent decadal surveys, provide appropriate guidance about science critical for the next decade of space exploration. **These reports[1] should be used as the primary scientific starting point for the NASA strategic roadmaps in the relevant areas.**

The second set is discipline specific and should provide guidance for setting priorities for critically important biomedical and microgravity research to enable human space exploration. **These reports[2] should be used as a starting point for setting priorities for research conducted on the International Space Station (ISS) so that it directly supports human exploration missions.**

Science for enabling long-duration human spaceflight cuts across many disciplines, spans many of the 13 agency objectives, and requires input from many science and technology fields. **NASA should identify science and technology areas critical for human exploration and move quickly to give those areas careful attention. The process should emphasize crosscutting reviews, result in rigorous priority setting, and utilize a broad range of scientific and technical expertise.**

NASA's robotic science program has enjoyed remarkable successful and can provide valuable lessons for the human spaceflight program. **Successful aspects of the robotic science program—especially its emphasis on having a clear strategic plan that is executed so as to build on incremental successes to sustain momentum, use resources efficiently, enforce priorities, and enable future breakthroughs—should be applied in the human spaceflight program.**

Concluding Comments. Science enabled by human exploration should compete with science identified in the decadal surveys and ranked according to the same rigorous criteria used in those surveys. Science to enable human exploration should compete according to how well it addresses critical problems and is likely to resolve those problems. Finally, the Presidential initiative provides direction for the future of the space

shuttle and the ISS. Carrying out those directions in the most cost-effective manner is essential for achieving NASA's exploration goals.

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[1] ***Astronomy and Astrophysics in the New*** *Millennium* (NRC, 2000), *New Frontiers in the Solar System: An Integrated Exploration Strategy* (NRC, 2002), *The Sun to the Earth—and Beyond: A Decadal Research Strategy in Solar and Space Physics* (NRC, 2002), and *Connecting Quarks with the Cosmos: Eleven Science Questions for the New Century* (NRC, 2003)

[2] ***A Strategy for Research in Space Biology and Medicine in the New*** *Century* (NRC, 1998), *Safe Passage: Astronaut Care for Exploration Missions* (IOM, 2001), *Factors Affecting the Utilization of the International Space Station for Research in the Biological and Physical Sciences* (NRC, 2002), *Microgravity Research in Support of Technologies for the Human Exploration and Development of Space and Planetary Bodies* (NRC, 2000), and *Assessment of Directions in Microgravity and Physical Sciences Research at NASA* (NRC, 2003)

For Further Information

Copies of the complete report, *Science in NASA's Vision for Space Exploration,* can be obtained from the Space Studies Board, The National Academies, 500 Fifth St., NW, Washington, DC, 20001, 202-334-3477, < http://books.nap.edu >.

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COMMITTEE ON THE SCIENTIFIC CONTEXT FOR SPACE EXPLORATION

Staff