

EXECUTIVE SUMMARY

The future of human space exploration is today at a crossroads. Thirty-three years have passed since man last set foot on the Moon, and in that time, human space exploration has been confined to low-earth orbit. Enormous strides have been made within other venues of space exploration during that time, but human activity in space has faced numerous challenges and setbacks in recent decades. Today, a number of countries (and non-state actors) have shown resurgent interest in human space activities, creating hope that a new reality can emerge.

This report looks at what it will take to change the reality of human space exploration today. It begins with a baseline overview in **Chapter I** of human space exploration activities around the world, based on public statements and the project team's visits with experts and leaders in many of the major space-faring nations during the last year. It then focuses on the broad set of interconnected challenges that the world must overcome if human space exploration is to move forward. These challenges fall generally into three categories: technology, governance, and public support.

Chapter II focuses on the technological challenges of human space exploration. It begins with a brief overview of the key technologies where progress must be made, including access to space, power and propulsion, crew health and safety, human habitats, and robotics. The chapter then examines the related challenges of managing innovation and technology, addressing questions about how space agencies should develop a technology roadmap, fund investments in R&D, and balance these investments among incremental and breakthrough technologies. It concludes with an overview of some of the technology-related policy challenges in human space exploration, including nuclear power in space, debris in Earth orbit, planetary protection, and technology transfer issues.

Chapter III looks at the governance-related issues for human space exploration, and the challenges of leading and organizing space activities. It contains an important section on international cooperation for human space exploration, looking closely at the key challenges associated with designing effective international cooperation. The chapter examines the relationship between the public and private sectors, and the challenges with ensuring that the two sectors can cooperate effectively and have optimally efficient investment incentives. The chapter concludes with an examination of the current legal context for human space exploration and the relevance of that framework for future space activities.

Chapter IV examines a third key challenge for human space activities: building and sustaining public support. The chapter begins with an assessment of the generic motivations for human space exploration, and their relation to each other. It then looks at the question of public opinion, and what the space community can do to build and sustain favorable public support. It examines the role of political leadership in public support. It concludes with a section on the related issue of developing the space workforce, and using the education system and other forms of outreach to inspire the next generation of space explorers around the world.

These three chapters establish the context for the recommendations put forward in **Chapter V**. These recommendations are intended to serve as catalysts – tools that might improve the

conditions for solving the more complex challenges of space exploration and moving the world forward toward a new era of human activity in space.

The five recommendations put forward in the report are:

1. Establish an **International Year of Space Exploration (IYSE) in 2011**, along the lines of the International Geophysical Year and the International Heliophysical Year. The year 2011 will be the 50th Anniversary of human spaceflight, commemorating Yuri Gagarin and Alan Shepard's first flights, and the demarcation of the IYSE can catalyze space exploration activity on a global basis.
2. Create a new **International Space Governance Forum**, which can serve as focal point for leadership on policy and governance issues. The Forum could:
 - Analyze exploration and policy proposals from a global perspective, independent of any national or private interests;
 - Share best practices across borders and putting forward broad and eclectic models that can guide future international initiatives;
 - Facilitate linkages on international cooperative projects;
 - Engage the space community on in-depth professional discussion of technical matters and mechanisms for international cooperation;
 - Conduct independent evaluation of roadmaps and technology concepts.

The Forum could be created at an existing institution such as the OECD or United Nations, or established as part of another appropriate organization.

3. Charter a new **Global Venture Fund for Space Exploration**. There are countless ideas found scattered throughout the private sector and the scientific community that might contribute, in a significant way, toward the development of a future human space exploration architecture. And there are millions of individuals around the world who would like to see the expansive development of space exploration, but have no direct means to support this work. A Global Venture Fund for Space Exploration could solve both of these needs, and solicit funds from national governments, the private sector, and individuals to invest in breakthrough research that can contribute to the development of human space exploration.
4. Establish an **International Prize for Space Exploration**. The space exploration community currently lacks a means to reward and provide incentives to those who have made the greatest contribution to space exploration activities, at the stature of the Nobel Prizes for Chemistry, Physics, and Medicine. A new International Prize for Space Exploration that would reward excellence in science, engineering, or other activities that significantly advance the future of human space exploration.
5. Make a renewed international commitment to **space education** on an international level building on related existing programs such as the GLOBE Program and UNESCO. Although national governments spend millions of dollars each year on space education activities, there is no single effort at present to interest and motivate

the next generation of researchers and explorers on a global basis. National governments and the private sector should support new multi-year efforts to build a broader base of interest in space exploration among young people around the world.

These five recommendations can collectively strengthen the global foundation and sense of purpose for human space exploration activities in the world today and can help to catalyze new efforts to improve governance, technology innovation, and public support of space exploration on an international level. They can reinforce ties within the space community and build new bridges to external constituencies at a relatively low cost and in short time. And while they may facilitate small steps to the larger goal of a global effort in human space exploration, without establishing some mechanism for moving forward, none of these recommendations will be accomplished.

The world of space exploration is at an inflection point today. The human race has the resources and capabilities to move forward to explore and settle new worlds; but there is an equal possibility that we will remain stuck where we have been for the last thirty years. This paper assesses how the world can avoid this latter path, and move forward toward a bold and adventurous future for human space exploration.