

## Why We Explore: The Value of Space Exploration for Future Generations

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### Abstract

The National Aeronautics and Space Administration (NASA) and its industry partners are making measurable progress toward delivering new human space transportation capabilities (Fig. 1) to serve as the catalyst for a new era of discovery, as directed by the U.S. Vision for Space Exploration.<sup>1</sup> In the interest of ensuring prolonged support, the Agency encourages space advocates of all stripes to accurately portray both the tangible and intangible benefits of space exploration, especially its value for future generations. This may be done not only by emphasizing the nation's return on its aerospace investment, but also by highlighting enabling security features and by promoting the scientific and technological benefits that accrue from the human exploration of space. As America embarks on a new era of leadership and international partnership on the next frontier, we are poised to master space by living off-planet on the Moon to prepare astronauts for longer journeys to Mars. These and other relevant facts should be clearly in the view of influential decision-makers and the American taxpayers, and we must increasingly involve those on whom the long-term sustainability of space exploration ultimately depends: America's youth. This paper will examine three areas of concrete benefits for future generations: fundamental security, economic enterprise, and high-technology advancements spurred by the innovation that scientific discovery demands.



**Fig. 1. Concepts of the Ares I crew launch vehicle (right) and Ares V cargo launch vehicle.**

Security has many facets. Sustaining the momentum of space exploration is no less compelling than sustaining the human race. In 2006, noted scientist Dr. Stephen Hawking became a vocal proponent of colonizing space, an elemental human preservation safety measure that is rarely discussed.<sup>2</sup> From a more immediate national security perspective, the U.S. Space Policy released in 2006 clearly states its intent to protect our country from adversaries who may use space tactics to disrupt and destroy vital assets such as communication and global positioning system satellites.<sup>3</sup> NASA technology and know-how can assist those on whom this important responsibility rests.

Although it may be convenient to look to history for inspiration or to depend on tradition to make the case for strength, it takes only a little imagination to extrapolate from a rich past to a richer future. The pioneering age of transportation has moved explorers to master the land, sea, airspace, and low-Earth orbit. Inevitably, transportation systems that were developed to meet specific government needs eventually benefited the masses. An example is the domestic aviation industry, which was spurred by the Department of Defense and the U.S. Post Office Department when it started airmail service routes in 1918.<sup>4</sup> From those humble beginnings, an initially U.S. Government-funded

service filled a high-demand market that grew into the vital present-day commercial air transportation industry. This is one of many examples of how the U.S. Government has stoked an economic engine that fulfills a market niche and then is transferred to the private sector — a model that is similar to NASA’s Commercial Orbital Transportation Services (COTS) demonstration. COTS is, in essence, a \$500 million down payment on potential cargo and crew services for the International Space Station, which offers a steady market for private space transportation providers.<sup>5</sup>

The Fiscal Year 2006 Federal budget was \$2.568 trillion, of which NASA’s share was \$16.2 billion, or less than 0.6 percent.<sup>6</sup> NASA, in turn, invested about 85 percent of its budget with industry to perform mission-related work.<sup>7</sup> It has been estimated that, on average, each dollar spent on U.S. research and development returns about \$9 in technology-induced economic gain.<sup>8</sup> The Federal Aviation Administration estimated that the U.S. commercial space transportation business alone, from which NASA procures services, generated \$98 billion annually in direct and indirect revenues in 2004.<sup>9</sup> The burgeoning space tourism business portends even more growth in this sector. But, perhaps the most important outcome of a strong U.S. space exploration program is that it delivers excitement to school children who are at a crossroads to decide whether to study math and physics. It has been estimated that the 5 percent of Americans engaged in science and engineering generate as much as 35 percent of U.S. exports; therefore, the ramifications of losing market share are enormous.<sup>10, 11</sup>

Technological inventions enable scientific results that rewrite textbooks, such as the astronomical surprises generated by the Hubble Space Telescope. From lightweight materials and miniaturized electronics, to medical breakthroughs, to defense-related intelligence gathering, to tracking natural resources, America’s space enterprise fuels an economic engine that yields not only critical knowledge, but technological marvels that become everyday conveniences. For example, as recently as a decade ago, soldiers in the field could not pinpoint their exact locations and the average driver had to rely on two-dimensional maps for navigation. Today, satellite-enabled global positioning data are harnessed by a host of hand-held and portable devices used by boaters, hikers, general aviators, and others. Solar power methods that will be developed for the planned lunar outpost may help generate new ways to harness this renewable resource on Earth.

These and numerous other benefits show that our country’s security, economy, and scientific and technological standing are intricately intertwined. The quality of life that we enjoy is linked with the advantages that space exploration enables. This is the backdrop against which future generations will measure the relevance and value of space exploration, which is a scientific endeavor that requires long-term planning and execution over a span of time. In a culture that is increasingly entertainment-oriented and that demands instant gratification, *how* we effectively frame and deliver these key messages is the source of much debate and will require a paradigm shift, which will be a subject for future papers.

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