To:    John Holdren, Director of the Office of Science and Technology Policy

From:  

Re:    America’s future of Mars exploration

Date:  June 8, 2012

Summary

Continued space exploration is important to both the American national identity and scientific advancement in general. Given a consideration of the benefits and drawbacks of unmanned Mars exploration versus manned Mars exploration preformed by the United States alone, the country should continue with unmanned programs. Considering the potential benefits of an international project to put humans on Mars, however, I feel this is a far preferable option to the either two if it is politically feasible in the United States.

Background

It hardly needs to be said that, since its beginnings, the American space program has been one of the greatest achievements of the United States and all humankind, and stands as one of the country’s greatest sources of national pride. Manned spaceflight reached its pinnacle in 1969 when American astronauts walked on the moon, and since then many people have considered landing a human being on Mars and safely returning them to Earth as the next great milestone in space exploration. Though the possibility of a manned flight to Mars was studied and plans were proposed throughout the remainder of the 20th century, with a mission to Mars realistically decades away, national interest in the space program waned following Apollo 11. In the 21st century, NASA landed two robotic rovers on Mars in 2004 that were only expected to operate for
three months to while making scientific observations, but they proved to be much more durable than expected; one of them only stopped functioning last year, and the other is still operable and exploring the planet.\footnote{Jet Propulsion Laboratory. "NASA Concludes Attempts to Contact Mars Rover Spirit." Jet Propulsion Laboratory Web site. May 24, 2011. http://www.jpl.nasa.gov/news/news.cfm?release=2011-156&cid=release_2011-156 (accessed June 8, 2012).} In 2011, NASA ended the space shuttle program, which many interpreted as a setback for manned spaceflight, and some even consider it an embarrassment to have astronauts taken into orbit by the Russian space program for the several years it will take before American private enterprises are prepared to launch\footnote{CBS. "Atlantis lands, NASA's shuttle program ends." CBS News. July 21, 2011. http://www.cbsnews.com/2100-205_162-20081323.html (accessed June 8, 2012).}. Partially in response to fears of the end of American manned space exploration, President Obama claimed in a speech that “we can send humans to orbit Mars and return them safely” by the mid 2030s, and land sometime thereafter.

Criteria, Opportunities, and Challenges

Any discussion of a manned mission to Mars would be accompanied by four major consideration points: technological feasibility, scientific gains, cost, and national pride. In addition to the scientific and technological benefits it would produce, projects like a Mars mission have the unique opportunity to be a source of unambiguous national pride; the awe-inspiring quality of the prospect of being able to leave Earth to explore new worlds and return can touch people at a nearly spiritual level, and allows them to feel like a part of something greater than themselves. At a time when the United States is strained under economic pressure and political divisiveness, one could argue that restoring national pride is vital to the country’s health. Conversely, it is difficult to quantify what benefits, if any, actually come from citizens merely feeling proud of their country. The main challenge to deciding how to proceed with Mars exploration is the numerous technical hurdles that would have to be overcome to do so, and the unclear price tag that would
be on such advancements. A critic could easily stake the claim that all those resources can and should be put into less risky policy investments with more tangible benefits, or in short that the opportunity cost is too great.

Options

Option 1 – Continued focus on unmanned space exploration with robotic probes

Option 2 – Independent American program for human exploration of Mars by 2030s

Option 3 – International collaboration for human exploration of Mars by 2030s

Analysis of Options

Option 1: For the past two decades, as computers and communications have grown more powerful, NASA has focused largely on conducting space exploration through the use of probes. The capability of machines to remotely carry out scientific observations and experiments was thoroughly vindicated by the Spirit and Opportunity Mars rovers, the functionality of which exceeded everyone’s wildest expectations. The latter of these is still operating today, seven years after it performed its 90-day mission. Probes are far more cost-effective than manned space exploration because no investment needs to be made in life support systems or return-trip capabilities, or the physical weight those components add to launch and voyage. The initial cost of Spirit and Opportunity was $820 million, and with additional appropriations due to their longevity the program has only cost a total of around $1 billion. A new, more advanced probe

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3 Ibid. 1
planned to land on Mars in August has an estimated total mission cost of $2.5 billion\(^5\). A manned mission is expected to cost anywhere from 10 to 200 times that amount\(^6\). Similarly, most experts feel that the presence of human beings will not provide much more scientific insight than probes already do. Former Congressman Barney Frank stated that the scientific consensus he was aware of believed the main benefit of a manned mission “is simply to show that we can do it” and “less productive from the standpoint of improving our knowledge of the universe…if we direct substantial amounts to human space travel\(^7\).” Another critic notes that NASA’s resources would be better spent “to fund several smaller unmanned missions to explore Mars and other planets” to spread risk, rather than attempting a mission to Mars. Though unmanned missions seem to dominate a potential manned mission, they generate little if any prestige or pride for the nation as a whole.

Option 2: There are a great deal of unknowns surrounding the prospect of sending a man to Mars in terms of cost, technological capability, scientific benefit, and the intangible benefits of national pride. Some proponents view this as yet again more reason to undertake such an endeavor because, like the Apollo missions, overcoming the challenges make it all the more worthwhile. Of what we do know, however, the cost was estimated in 2007 to be a range of anywhere from $20 to $450 billion dollars\(^8\). As mentioned above, most scientists feel that a human presence on Mars will not be able to add much more to our scientific observation capabilities than can be achieved with probes. A round trip to Mars from Earth would take at least one year and probably more, which would require the development of solutions to such...


\(^{8}\) Ibid. 6
problems as shielding the crew from prolonged exposure to cosmic radiation\textsuperscript{9}, the physical effects on the crew of prolonged weightlessness, and the psychological effects on the crew of being separated from Earth for that time period. These may be mitigated, however, if greater investment could quicken the development of new space propulsion systems that might cut the trip to Mars down to only 40 days\textsuperscript{10}. There is no doubt that a national effort to land a man on Mars would renew national interest in the space program and our sense of purpose. Embarking on this program would prevent the brain-drain that experts fear will hit NASA in the absence of the shuttle program\textsuperscript{11}, and Dr. Robert Zubrin believes it would inspire “millions of young scientists, engineers, inventors, and medical researchers, making technological innovations…that utterly dwarfs the expenditures of the Mars program\textsuperscript{12}.” National pride, however, also tends to be contingent on success. Americans and the rest of the world were inspired by Apollo 11 because it got to the moon; it is quite possible that, had the events of Apollo 13 transpired on the first attempt, national opinion would have turned against the program as too risky. The much longer timeframe needed for a Mars mission only increases the risk of a failure that might turn the project into an embarrassment. Similarly, national pride would be undermined if another nation were to take up America’s mission as a challenge and subsequently land a man on Mars before the United States, in just the same way as America beat the Soviet Union to the moon after they were the first in orbit.

\textsuperscript{12} Ibid. 7
Option 3: A strong case could be made for forming an international effort to send humans to Mars. The only challenge added to the prospect of an independent American mission is that of international cooperation and coordination, which in this case is a comparatively small issue; while international problem solving is often riddled with difficulties, several nations’ space programs have already worked together to develop and construct the International Space Station. The high cost of resources and technical expertise would be divided among the world’s most advanced nations, as the United States, China, Russia, India, Japan, and the European Union all have active space programs. Finally, though such a project might not engender national pride for American citizens, the moon landing was a historic achievement for all of mankind; to have nations across the world sharing in a Mars landing would be an unprecedented moment of global unity, with the possibility of an even greater bounty of intangible benefits than that conferred by “American leadership in space.”

Recommendation
I recommend option 3, an international Mars mission, because it mitigates most of the risks and costliness of an American solo venture to land a man on Mars, while adding the incalculable potential benefits of a sense of global unity. Whereas the American moon landing was the pinnacle of a 20th century marked by nationalism and international struggles, an international Mars landing could be the crowning achievement of a 21st century that has already seen the dawn of globalization and could yet see the development of real international cooperation. If this is politically unachievable, however, option 1 of continuing unmanned exploration of Mars and the solar system is far more beneficial relative to the potential risks involved.