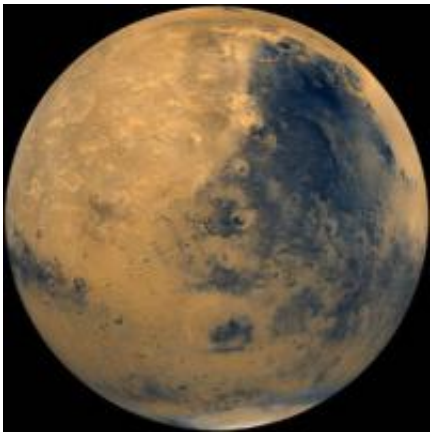
NASA should maintain long-term focus on Mars as 'horizon goal' for human spaceflight

June 4 2014



Mars. Image: NASA

Arguing for a continuation of the nation's human space exploration program, a new congressionally mandated report from the National Research Council concludes that the expense of human spaceflight and the dangers to the astronauts involved can be justified only by the goal of putting humans on other worlds. The report recommends that the nation pursue a disciplined "pathway" approach that encompasses executing a specific sequence of intermediate accomplishments and destinations leading to the "horizon goal" of putting humans on Mars. The success of this approach would require a steadfast commitment to a consensus goal, international collaboration, and a budget that increases by more than the rate of inflation.

"The United States has been a leader in human space exploration for more than five decades, and our efforts in low Earth orbit with our partners are approaching maturity with the completion of the International Space Station. We as a nation must decide now how to embark on human space exploration beyond low Earth orbit in a sustainable fashion," said Jonathan Lunine, director of the Center for Radiophysics and Space Research at Cornell University and co-chair of the committee that wrote the report.

"The technical analysis completed for this study shows that for the foreseeable future, the only feasible destinations for human exploration are the moon, asteroids, Mars, and the moons of Mars," Lunine added. "Among this small set of plausible goals, the most distant and difficult is putting human boots on the surface of Mars, thus that is the horizon goal for human space exploration. All long-range space programs by our potential partners converge on this goal."

Public opinion of the space program since its inception has been generally positive, but the report found that most of the public does not pay much attention to or feel well-informed about the topic and spending on space exploration is not a high priority for most of the public. Support for increased funding is highest among those who are interested in and well-informed about human spaceflight. The committee conducted its own survey of stakeholders (defined as those who may reasonably be expected to have an interest in NASA programs and be able to exert some influence over its direction) and scientists in non-space-related fields. In both the public and stakeholder opinion data, the committee found there was no majority agreement on a single rationale for human spaceflight.

Historically, rationales used to justify a human spaceflight program have included economic benefits, national security, national stature and international relations, inspiration for science and engineering education,

contributions to science and knowledge, a shared human destiny and urge to explore, and the eventual survival of the human species—the report defines the latter two as "aspirational."

The committee concluded that although no single rationale, either practical or aspirational, seems to justify the value of pursuing human spaceflight, the aspirational rationales, when supplemented by practical benefits associated with the pragmatic rationales, argue for the continuation of a U.S. human spaceflight program, provided that the program adopts a stable and sustainable pathways approach. The aspirational rationales are also most in line with enduring questions the report identifies as motivating human spaceflight: How far from Earth can humans go? and What can humans discover and achieve when we get there?

"Human space exploration remains vital to the national interest for inspirational and aspirational reasons that appeal to a broad range of U.S. citizens," said Purdue University president, former Governor of Indiana, and committee co-chair Mitchell E. Daniels, Jr. "But given the expense of any human spaceflight program and the significant risk to the crews involved, in our view the only pathways that fit these criteria are those that ultimately place humans on other worlds."

The report evaluates three different pathways to illustrate the trade-offs among affordability, schedule, developmental risk, and the frequency of missions for different sequences of intermediate destinations. All the pathways culminate in landing on the surface of Mars—which is the most challenging yet technically feasible destination—and have anywhere between three and six steps that include some combination of missions to asteroids, the moon, and Martian moons.

The report proposes a set of principles and decision rules by which national leadership might decide on a given pathway, measure its

progress, navigate moving off one pathway to another, or cease the endeavor altogether. While the committee was not asked to recommend a particular pathway to pursue, it found that a return to extended surface operations on the moon would make significant contributions to a strategy ultimately aimed at landing people on Mars, and that it would also likely provide a broad array of opportunities for international and commercial cooperation.

Completing any of the described pathways requires the development of a number of mission elements and technological capabilities. The report identifies 10 high-priority capabilities that should be addressed by current research and development activities, with a particular emphasis on Mars entry, descent, and landing, radiation safety, and in-space propulsion and power. These three capabilities will be the most difficult to develop in terms of costs, schedule, technical challenges, and gaps between current and needed abilities, the report says.

Progress in human space exploration beyond low Earth orbit will be measured in decades and hundreds of billions of dollars. Although the report does not make any particular budget recommendations, it notes that there are no viable pathways to Mars under the current flat or even an inflation-adjusted budget. The analysis does show that increasing NASA's human spaceflight budget by 5 percent per year, for example, would enable pathways with viable mission frequency and greatly reduce technical, cost, and schedule risks.

"Our committee concluded that any human exploration program will only succeed if it is appropriately funded and receives a sustained commitment on the part of those who govern our nation. That commitment cannot change direction election after election. Our elected leaders are the critical enablers of the nation's investment in human spaceflight, and only they can assure that the leadership, personnel, governance, and resources are in place in our human exploration

program," Daniels said.

Provided by National Academy of Sciences