

Recommendations for the Human Space Flight Committee

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Our nation is at a crossroads in history - we have developed the technology to live and work off our home world, but we do not have any clear vision of how or if to use this technology. We are also running into physical limits of energy usage and resource consumption. History also teaches us that societies which grow become more prosperous whereas societies that stagnate tend to wither and die.

We can continue economic growth while overcoming these limits if we set our nation's human spaceflight goal to be the industrialization and colonization of space (see Gerard K. O'Neill, *The High Frontier*, for an excellent description of these concepts). The industrialization of space would give us inexpensive, clean, limitless solar electric power, as well as access to vast mineral resources in the asteroid belt. The colonization of space provides for nearly limitless growth for our society and economy as well as protection of our society from earthly catastrophes. (Dr. Gott's commentary to this committee is very compelling). If we adopt this goal for the long term, and spend our money wisely over the coming decades, we could accomplish it within a generation or two.

What must NASA do with human spaceflight in order to accomplish this goal? First and foremost, the agency must focus on research and technology development to lower the cost of reaching and returning from low earth orbit. The research should focus on long term and difficult problems that will not be solved by businesses because of either high risk or long investment recovery time. Critical areas of research are thermal protection systems; cheaper, more robust rocket motors; laser, microwave, or other beamed energy propulsion systems; hybrid propulsion systems that can function from subsonic to hypersonic regimes; etc. The choice of research projects should be determined by all stakeholders in the colonization goal.

Second, NASA and the US Government must provide an environment for the New Space companies like SpaceX, XCOR, and Bigelow Aerospace to succeed economically. The COTS initiative for space station resupply as well as the FAA AST office are both excellent examples of how to provide such an environment. If spaceflight becomes more profitable for more businesses, much of the industrialization and colonization may happen on its own.

Third, NASA must continue its scientific research programs so we can better understand the space environment.

With these perspectives in mind, the decisions on our current space resources and the planned Vision for Space Exploration become somewhat easier. We should operate the Space Station for the foreseeable future because it provides a base to store material and assemble larger structures in addition to its existing research function. (The idea of abandoning it a few years after completion is foolishly wasteful).

We will need to build another crew carrier to the Space Station, and we need to do that quickly -- the long gap after the Shuttle retires was a big mistake. The choice between Ares I versus man rating existing launch vehicles should be based first on reducing the length of gap, and second on cost. In addition, if one of the new companies can provide the service, like SpaceX, then that should be our choice.

However, we will need another heavier lift vehicle like the Ares V, although we should design a flexible architecture that would allow us to tailor the vehicle to the mission (similar to the Atlas V family). The reuse of Saturn and shuttle components is a very cost effective approach.

Finally, should we set Mars as a goal? If we adopt space industrialization and colonization as our goal, then getting to Mars will happen by itself. All the infrastructure will already be in space with people living there, and getting to Mars will be part of life.