Space Policy 30 (2014) 163–169

Contents lists available at ScienceDirect

Space Policy

journal homepage: www.elsevier.com/locate/spacepol

Human spaceflight and an asteroid redirect mission: Why?

M.J. Burchell*

Centre for Astrophysics and Planetary Science, University of Kent, Canterbury, Kent CT2 7NH, United Kingdom

ARTICLE INFO

Article history:
Received 22 July 2014
Accepted 22 July 2014
Available online 24 September 2014

Keywords:
Astronauts
Asteroid
Capture
Moon
Mars
Sample return
Human spaceflight

ABSTRACT

The planning of human spaceflight programmes is an exercise in careful rationing of a scarce and expensive resource. Current NASA plans are to develop the new capability for human-rated launch into space to replace the Space Transportation System (STS), more commonly known as the Space Shuttle, combined with a heavy lift capability, and followed by an eventual Mars mission. As an intermediate step towards Mars, NASA proposes to venture beyond Low Earth Orbit to cis-lunar space to visit a small asteroid which will be captured and moved to lunar orbit by a separate robotic mission. The rationale for this and how to garner support from the scientific community for such an asteroid mission are discussed. Key points that emerge are that a programme usually has greater legitimacy when it emerges from public debate, mostly via a Presidential Commission, a report by the National Research Council or a Decadal Review of science goals etc. Also, human spaceflight missions need to have support from a wide range of interested communities. Accordingly, an outline scientific case for a human visit to an asteroid is made. Further, it is argued here that the scientific interest in an asteroid mission needs to be included early in the planning stages, so that the appropriate capabilities (here the need for drilling cores and carrying equipment to, and returning samples from, the asteroid) can be included.

1. Introduction

Human spaceflight is a rare, expensive activity. Although there are attempts at human spaceflight by private enterprise providers, it is still a largely government funded activity (albeit one where at times private individuals have purchased rides into space). The drivers for human spaceflight therefore have to be ones to which governments favourably respond. Traditionally, national prestige and keeping up with, or ahead of, your international rivals was sufficient. Such a rivalry sent men to the Moon in the Apollo era. Today, we only send men and women to Low Earth Orbit. The social and economic conditions in the United States in the 1970s, and the slow economic collapse of the Soviet Union, have removed the driver for venturing into deeper space. Instead, access to Low Earth Orbit proved sufficient for the, then, two nations capable of launching humans into space (for a discussion of the US Space Programme up to the early 1990s, see Ref. [1]).

Attempts to change this dominant human spaceflight paradigm of “so far, but no further” have all failed during the last 20 years (e.g. Ref. [2]). In the United States for example, attempts to build a Mars roadmap which would include astronauts visiting Mars (e.g. Ref. [3]), came and went (e.g. the Constellation programme started under President G.W. Bush and cancelled under President Obama), with indeed a loss for some years now of the US astronaut launch capability (the STS space shuttle – Orion gap). Proposals for the direction of human spaceflight continued to emphasise reaching Mars on a capability development driven path, e.g. Refs. [4], but the NASA strategy that emerged in 2011 [5] only gave building the development of a human spaceflight capability beyond Low Earth Orbit as the priority. The path for human spaceflight that then emerged in the United States in 2012, is a capability driven one that will, eventually, take humans to Mars, but which now includes an asteroid redirect mission (ARM) as a major intermediate step before going to Mars (e.g. Ref. [6]). The ARM involves moving a small (10 m sized) asteroid to lunar orbit and visiting it with astronauts. The astronauts would conduct experiments to examine the asteroid's surface and, in a perfect mission scenario, its entire interior.

But this capability driven strategy involving an ARM has proven controversial. The possible causes of this conflict are explored further herein.

2. Stakeholders

When discussing the topic of human spaceflight it is useful to reflect on the different groups who have an interest in it. For example, the scientific community has a strong commitment to solar system science. This commitment includes exploration,

* Tel.: +44 (0) 1227 827833.
E-mail address: m.j.burchell@kent.ac.uk.

http://dx.doi.org/10.1016/j.spacepol.2014.07.003
0265-9646/

planetary science, solar-terrestrial physics, Earth observation, etc. There are also strong communities of astronomers who use space-based telescopes to make observations difficult or impossible to make from the Earth's surface. And there are physicists who wish to make measurements of fundamental physics phenomena for which space is the ideal laboratory.

There is also a broader group of scientists and engineers for whom space is simply an environment with attractive features, where they can conduct experiments difficult to perform on Earth. Hence, for example, the micro-g environment of the International Space Station (ISS) is widely used for experiments across a range of disciplines which need a prolonged micro-g exposure. Most of this community are happy with Low Earth orbit and need to go no further into space, although some at times suggest that the radio quiet environment of the lunar far-side is attractive, e.g. Refs. [7,8].

Spacecraft engineers are also interested in access to space. That space is, to us, an unusual environment should not be forgotten. Developing and testing materials and systems to work in this harsh, novel environment is a real challenge. And human space flight also presents questions about how to support life on prolonged missions that are non-trivial, and still not fully explored by the various long duration space stations which even today require frequent re-supply.

The interest of the general public in human spaceflight should also not be forgotten. In democracies where government spending is requested in many areas, just how pressing is human spaceflight? Ultimately, unless there is public support, any government spending is vulnerable to challenge.

This approach however, defines interested parties by their occupation. An alternative is to consider their goals. In this respect another group clearly emerges, those who see space as the high frontier, a place to be brought fully into the sphere of human economic and social activity. Whilst idealistic, this does at least give a long term vision against which plans can be set.

3. Motivations

NASA now has a strategy for space exploration which includes human spaceflight (see Refs. [5,6]) and which is dictating hardware development and mission planning. One lesson from earlier plans is that activities must be budget driven. This constraint may be self-evidently sensible, but it implies that unless a budget exists there is no point in planning an activity. Or, if an activity has been planned, it can only be implemented on a timescale which is dictated by when the budget is available. External commentators and interested parties, thus have to understand and accept that actions are constrained by the budget.

The NASA plan includes a broad approach to exploring and eventually exploiting space and the Solar System, which implicitly recognises the need for leadership by the state. The costs of pioneering activity in this sector are high, with the potential returns unclear. Nevertheless, the enormous value to the global economy of activity in Earth orbit shows that significant returns are possible, once access to space was gained. The issue remains how to show similar returns from activity beyond Earth orbit; until this is achieved solar system exploration remains a public good which is accordingly funded through government expenditure.

Finally, solar system exploration is not only expensive, it is also a long term project. Thus any plan has to be long term and extend over several administrations. It must also retain public good will and interest over long periods.

4. Robotics vs. astronauts

Given that space exploration beyond Earth orbit is currently driven by the public sector, the main user groups are likely to be the military, scientists or engineers. Once beyond Earth orbit it is not immediately clear if any direct military advantage pertains, leaving scientists and engineers as the main users. It is perhaps unfortunate that a major schism exists inside these groups (particularly the scientists) between those who favour robotic exploration vs. those interested in human based exploration.

The reason for this difference in views undoubtedly lies in tension in funding. Even when separate funding lines exist, a belief arises that “if only”, which leads one side to view the other with suspicion. This suspicion is no doubt exacerbated by the different rates of progress and different goals of both camps. For robotic exploration, the past 20 or so years have truly been a golden age. Mission after mission has travelled to planets, asteroids and comets, and revolutionised our knowledge and understanding of these bodies. It should not be forgotten however, that before the mid-1990s robotic exploration was running the risk of becoming a slow moving, high cost exercise, with single, expensive ($3bn+), large missions once per decade, or even less frequently. In 1992, a paradigm shift, “faster, better, cheaper”, championed by the then NASA Administrator (D. Goldin), started to focus NASA, and the robotic community, on delivering science across the solar system, by multiple, (relatively) cheap, quick missions as well as via long duration missions (usually to the outer solar system). Whilst proving at times controversial (e.g. see Ref. [9] for a discussion) it was also enormously beneficial (e.g. see Ref. [10]), enabling the strong, successful robotic based, broad based solar exploration community that now exists. Drawing this community, and its goals, together with the human spaceflight sector poses problems, some of which are inherent in the “faster, better, cheaper” mantra which generally does not apply to human spaceflight, which by its nature is still cautious, slow and expensive.

In parallel to the frequent, cheaper robotic missions, now a common feature of planetary exploration, there are still less frequent, more expensive robotic missions at the $bn scale. The on-going Cassini mission around Saturn and some of the recent Mars rover missions illustrate the value of these missions. In the case of missions to the outer Solar System, the timescales involved still preclude a human mission. In the case of Mars, the cost and complexity are still, however, significantly lower than for a human mission to the same destination. Indeed technological developments are still needed for a successful human mission to Mars, hence the capability led strategy NASA has adopted for its Mars led human spaceflight programme.

5. Asteroid redirect mission: why and Cui Bono?

The new US human spaceflight capability currently in development, explicitly looks beyond Earth orbit. To this end the launchers have to have significant lift capability, capable of providing a large energy boost, sufficient to impart a velocity capable of reaching deep space to a crewed vehicle. Since such a mission will be long duration, the human module must be self-sustained for a long period. The mid-to-long term destination for such a vehicle is often simply assumed to be Mars. However, if human spaceflight in deep space is to avoid the future equivalent of the post-Apollo blues, and not retreat again to Low Earth orbit, a more detailed rationale needs to be developed other than just going to Mars.

The capability driven plan approach partially offers a solution to this. This approach explores what skills and experiences are needed, and what hardware is required to deliver the Mars vision. The key steps needed to successfully get to Mars (and back) are thus definable. The approach still leaves vague however what happens after the first Mars mission. Considering the fate of the Apollo missions, this may prove a fatal deficiency.