Acta Astronautica 69 (2011) 346–353

Contents lists available at ScienceDirect

Acta Astronautica

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

Comparing future options for human space flight ☆

Brent Sherwood

NASA Jet Propulsion Laboratory, Office 150, 4800 Oak Drove Dr, M/S 301-335, Pasadena, CA 91109, USA

ARTICLE INFO

Article history:
Received 31 January 2011
Accepted 16 April 2011
Available online 11 May 2011

Keywords:
Human space flight
Exploration
Mars
Moon
Space solar power
Tourism
Passenger travel
Colonization
Myth
Strategy

ABSTRACT

The paper analyzes the "value proposition" for government-funded human space flight, a vexing question that persistently dogs efforts to justify its 10^{10}/year expense in the US. The original Mercury/Gemini/Apollo value proposition is not valid today. Neither was it the value proposition actually promoted by von Braun, which the post-Apollo 80% of human space flight history has persistently attempted to fulfill. Divergent potential objectives for human space flight are captured in four strategic options—*Explore Mars*; accelerate *Space Passenger Travel*; enable *Space Power for Earth*; and *Settle the Moon*—which are then analyzed for their purpose, societal myth, legacy benefits, core needs, and result as measured by the number and type of humans they would fly in space. This simple framework is proposed as a way to support productive dialog with public and other stakeholders, to determine a sustainable value proposition for human space flight.

1. Introduction

> The future is highly unpredictable. Creative, adaptive behavior that is based on value has more value than goal or mission-directed behavior, which is always based to some extent on historical analysis. History is going to be of less use to us in the future.
>
> J. Rohde [1], VP/Creative, Disney Imagineering

Civilization uses governments to accomplish what no individual, corporation, or consortium can afford. All government ideas, plans, investments, and projects for human space flight (HSF) can be and eventually are judged against their fundamental value proposition. Passing this judgment requires HSF programs to know clearly what their value proposition is. Given events of the past four decades, and cyclical replanning, reasonable questions in 2010 are: What *is* the value proposition for government investment in HSF [2] and what should it be?

This paper explores these questions, seeking answers deeper and less vague than "destiny" or "technological innovation" or "the drive to explore." It finds just four alternative value propositions for government investment in human presence beyond the International Space Station (ISS). These four options are startlingly different. They are easy to explain to ordinary people, which makes them useful for probing public interest and commitment. They would be an easy "litmus test" of relevance for proposed priorities and projects. Interestingly the option pursued by the US HSF program has not fundamentally changed from the time of von Braun, despite numerous changes in societal context, leadership, technology, or risk tolerance. Stepping back to compare the four options may be appropriate for the challenges of our time and our shared desire for more HSF progress.

2. Value propositions yesterday and today

A very terrestrial value proposition—proving global technological dominance—propelled the first decade of government-funded HSF, as is well understood. However,

☆ This paper was presented during the 61st IAC in Prague.

E-mail address: brent.sherwood@jpl.nasa.gov

0094-5765/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.actaastro.2011.04.006

upon its fruition (first with the Apollo Moon landings of 1969–1972, and ultimately with the Soviet Union's dissolution 20 years later) there was no further value to be extracted from this proposition.

NASA's last major project (ISS) took a quarter century to complete—ten times the typical job tenure of today's graduates. Although the public remains vaguely proud of NASA, people have no idea what human space flight costs or how this compares to other government programs. They cannot name astronauts or what their missions do. Also they cannot explain any connection between HSF and their quotidian problems. What might today's HSF value proposition be?

The last four decades of HSF have appeared to be about "laboratories in space," progressing from *Skylab* and *Salyut* to *Mir* and culminating in the ISS. Three sociological points provide important clues for understanding how HSF is viewed by our society today. First is the reduced pace of this period compared to the Apollo era—four decades rather than one—caused by absence of national urgency and technical challenge we discovered along the way. This factor-of-four time dilation requires a sustainment of public attention that conflicts with the decreasing attention span of today's stakeholders. Second is that the astounding achievement of ISS is sometimes derided as "going in circles" and thus somehow intrinsically not worthy because it is not "exploring" a frontier. Evidently fundamental research and learning are less interesting than pressing outward. Third, likely because of the time dilation, neither the Shuttle nor Freedom/ISS was recognizable to the public for what they actually were—elements gradually implementing the three-step HSF blueprint laid out by von Braun in the 1950s: reusable space shuttle, orbiting space station, and humans to Mars [3,4]. Over four decades the public "lost lock" on the grand plan.

Nonetheless, *Explore Mars* has always been the implicit value proposition of US human space flight. It pre-dated Kennedy's superposition of the geopolitical value proposition that got Apollo to the Moon, biding its time during that era and then riding Apollo's momentum up to this point.

It is still our value proposition. The Space Exploration Initiative announced in July of 1989 put the US on a path "back to the Moon, this time to stay, and then [on] to Mars" [5]. Despite inadequate funds to do more than "go in circles" anyway, debate simmered about whether our next "destination" should be Mars or the Moon. Earnest factions competed to promote nuclear technologies, "Mars Direct," *in situ* resource utilization, astronomy from the lunar surface, outpost vs. sortie, and so forth [6]. Fifteen years later, the Vision for Space Exploration announced in January of 2004 established priorities by proffering the Moon as an affordable stepping stone to Mars [7–9]. However, the US declined to afford that strategy also. After a change in presidential administration the Future of US Human Space Flight Plans Committee (aka Augustine Committee) proposed a "Flexible Path" strategy to extend human presence into deep space "with no immediate plans for planet surface exploration," yet at the same time reasserting Mars as the "ultimate destination" for HSF [10]. The Obama Administration embodied this approach in budget proposals, and the President himself challenged NASA on April 15, 2010, to launch a first human mission to an asteroid by 2025, and reach Mars orbit in the mid-2030s. NASA's Human Exploration Framework Team calls Mars the "horizon destination" for HSF.

Apparently *Explore Mars* is a refractory meme: fired in von Braun's own crucible, it has outlasted a half century of world history, eleven US Presidents, 25 US Congresses, 50 NASA budget cycles, three generations of aerospace professionals, Apollo and two other attempts to compromise on the Moon, and the ascendancy of robotic exploration, which has replaced romantic visions of an inhabited Mars with the real possibility that Mars may have once harbored microbial life. That humans could and someday will *Explore Mars* has become a full-fledged modern myth.

3. Myths and societal motivation

Betty Sue Flowers [11], poet and former Shell Oil executive, speaks about how societal "myths" apply to the HSF enterprise. She defines myths as stories "that create meaningful reality," stories we use to organize and prioritize values and experiences, stories so embedded into society's core that they are deeply, widely, and instantly understandable. Myths are continually reinforced by reference: in stereotypes, humor, the media, and innumerable other outlets. She describes three "myths that made us:" *Hero*, *Religious*, and *Democratic/Scientific*, and finds that the modern developed world exists in an *Economic* myth that "maximizes advantage" using numbers to measure the "bottom line." Finally, she posits a new, inchoate myth: *Ecological*, in which individuals contribute to a networked whole.

Flowers implies that to succeed in the constant competition for public favor, HSF must know which myths it means to embody and intentionally utilize resonance with myths to win society's support. "When you don't know what myth people are in when they're telling their individual story, you don't really know what's going on." If HSF were to live "between" myths (Hero? Economic?), or be about one myth (Scientific?) but attempt to communicate through another (Economic?), its value proposition would be confusing, defocused, even self-contradictory, and not widely compelling, and it would fail. The key measure of failure would be declining societal relevance, then political will, and eventually funding. History demonstrates that when society turns its attention and commitment elsewhere, the cathedral remains unfinished.

Are signs of failure upon us? As Bob Rogers [12] observes NASA worked hard to make orbital space flight appear routine, an outcome which undercut its original Hero myth and then led to damaged public trust after *Challenger* and *Columbia* demonstrated that it is not yet routine. Now even most space professionals cannot name the crew currently onboard ISS; although they are heroes in the sense of facing personal danger to achieve important things on behalf of society, they no longer live in society's Hero myth.

What about the important things they are doing? Again, even most space professionals cannot name the litany of research investigations currently underway on ISS. In the mid-20th century scientists were also heroes—elite warriors safeguarding freedom and improving our quality of life. Now white-coated scientists are Gary Larson caricatures seen as