Thoughts on a Mars Exploration Program after 2020: Will Human Exploration and Science Converge?

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Mars Program Post 2020 – Decadal Science

- The highest-priority flagship mission for the decade 2013-2022 is the Mars Astrobiology Explorer-Cacher (MAX-C), **which will begin a three-mission NASA-ESA Mars Sample Return campaign extending into the decade beyond 2022.**

- **…the two subsequent missions in the Mars Sample Return campaign would take place after 2022.** The timing is flexible; as described in Chapter 6, the MAX-C sample cache is designed to remain scientifically viable for at least 20 years**. The committee has therefore taken the unusual step of recommending a plan for the coming decade that also has significant budget implications for one or even two decades beyond.** The committee does this intentionally and explicitly, with the realization that **important multi-decade efforts like Mars Sample Return can come about only if such recommendations are made and followed.**

The Decadal unambiguously recommended Mars Sample Return after 2020

Science and NASA's Human Exploration Program

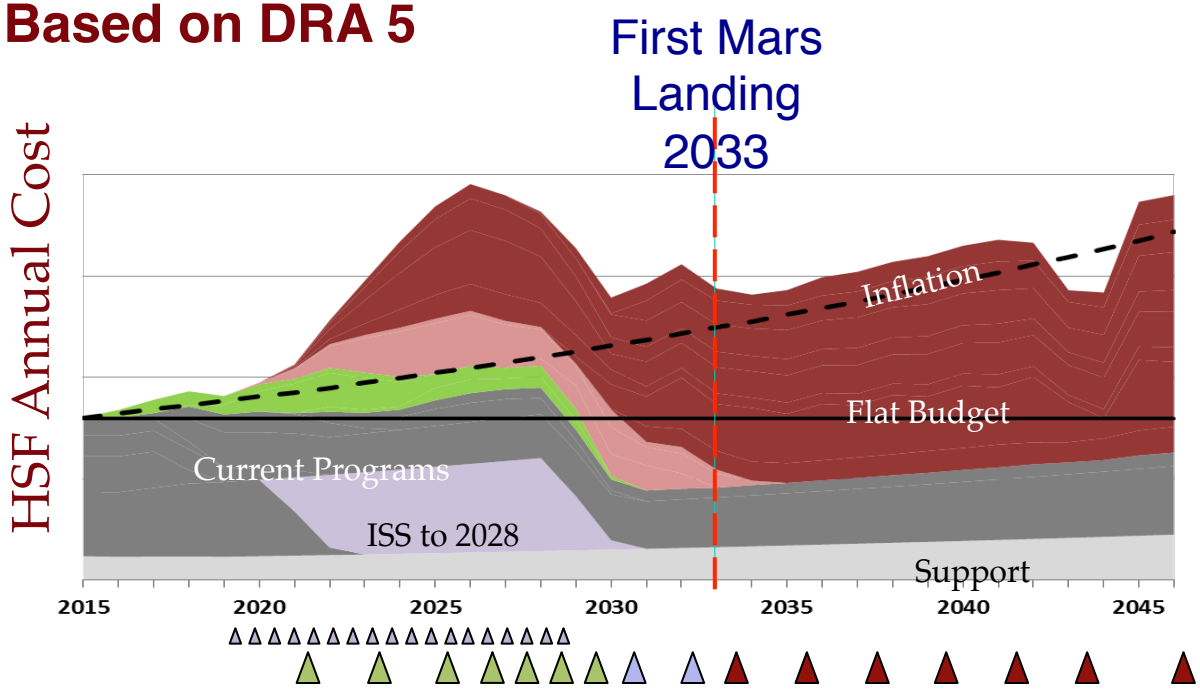
Planetary Decadal Survey (summary page 63)

- For decades, planetary science has adopted a graduated, step-wise approach to exploration, from initial flyby to orbital reconnaissance, followed by in situ investigation and ultimately a return of samples to laboratories for exhaustive examination. Although humans are not required for the return of samples from the Moon, asteroids, or Mars, **if humans are going to visit these bodies, collecting and returning high-quality samples are among the most scientifically important things they can do.**
- The robotic and human exploration of space should be synergistic, both at the program level (e.g., science probes to Mars and humans to Mars) and at the operational level (e.g., humans with robotic assistants). Both drive the development of new technologies to accomplish objectives at new destinations. However, **this effort must proceed without burdening the space science budget or influencing its process of peer-review-based selection of science missions.** Conversely, NASA can proceed to develop the robotic component of its human exploration program.

What About Humans to Mars (H2M)?

- National Research Council 2014 study on human spaceflight (Pathways to Exploration) stated that Mars was the "horizon goal".
- However, cost analysis using a fixed budget (with inflation) and NASA's so-called Design Reference Architecture (DRA) #5, from 2009, resulted in a program where humans do not land on Mars until ~2050's. (Chapter 4, p. 162. Table 4.32)
- Accelerated H2M (2033 landing) required huge increases in NASA's human spaceflight budget

Based on DRA 5



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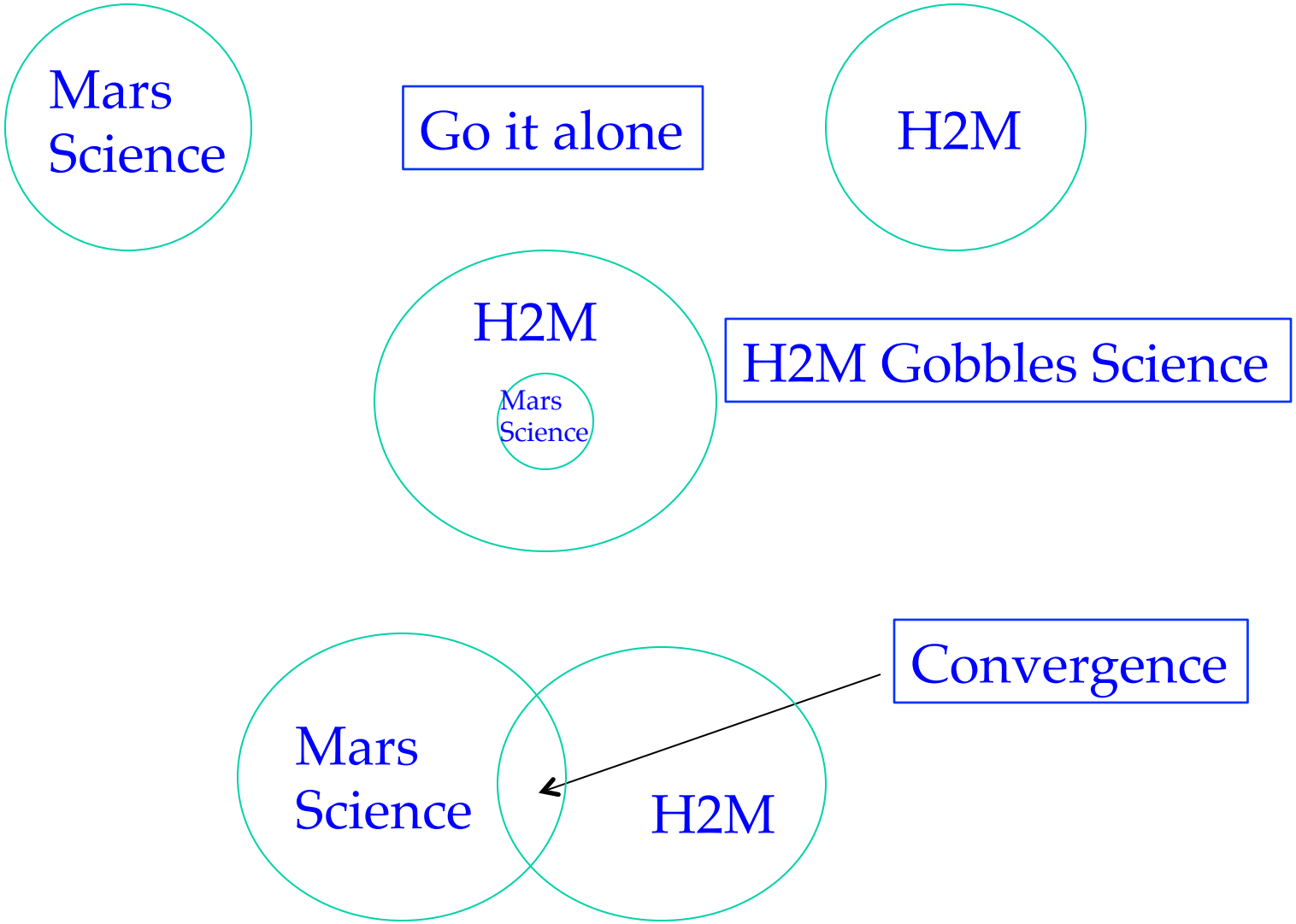
Where is the H2M Effort Today?

- Many initiatives and workshops conducted or underway (Affording Mars, Inspiration Mars, Mars One, Pioneering Space, Planetary Society Humans Orbiting Mars and so on).
- Currently, only NASA has the budget to realistically contemplate H2M.
- NASA's stated position (per response to the NASA Advisory Council recommendation) is:
  - Current program is "Evolvable Mars" a series of "capabilities-based" efforts that "hold open architecture decisions".
- Evolvable Mars was criticized by members of the NAC as having no overarching strategy. "By 20 years from now NASA will have spent $160B and be no closer to Humans on Mars than we are today..", Tom Young
- If there is to be an executable H2M Program, there must be a different approach than Evolvable Mars or DRA#5
  - At The Planetary Society workshop an existence proof for a long term, affordable H2M was presented - assuming a minimalist, high "TRL" approach
- What will be the role of science?

Collaboration and Convergence or Not

- **Possible integrated and expanded human and robotic science objectives**



Mars Exploration as a Common Goal for NASA