2013 Humans to Mars Summit Recap

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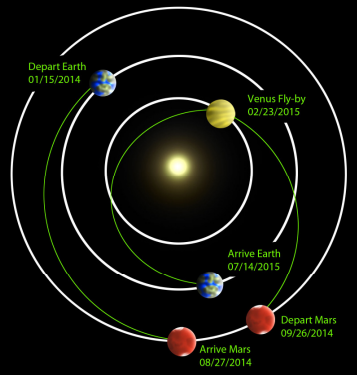
H2M Summary Outline

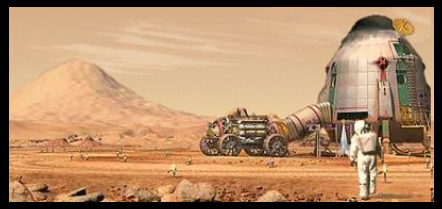
How we will prepare:

- Precursor Missions Panel
- Science and Engineering Panel
- Mission Architecture and Transportation Panels
- Propulsion Options Panel



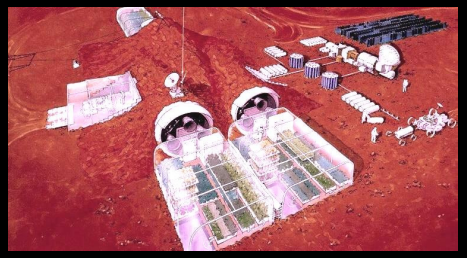
How we will do it:

- Biomedical Panel
- Entry Descent and Landing Panel
- Living on Mars: Life Support Panel
- Mars Agra Panel



Now, how do we make it happen:

- Inspiration Mars Panel
- Policy Panel
- Summary of H2M Summit



Background: What was the Humans to Mars Summit?

- A 3 day technical conference in Washington DC, exploring how to achieve a human landing on Mars by the 2030's.
- A gathering of space leadership from NASA, Boeing, Lockheed, and other large NASA contractors
- Sponsored by Explore Mars, a space exploration advocacy group, hosted by Explore Mars President Artemis Westenberg
- Ran from May 6th through May 8th on the campus of George Washington University, which hosts the GW Space Policy Institute
- Four largest Explore Mars H2M sponsors: Boeing, Lockheed Martin, ATK, and Aerojet

ExploreMars.org

BOEING

ATK

LOCKHEED MARTIN

AEROJET

A renewed public acknowledgement that NASA must exercise leadership with a Human Mission to Mars

H2M Agenda (Selected Portions)

May 6, 2013

Human and Robotic Precursor Missions Panel
Science and Engineering Panel
Mars Science Missions Update Panel
Human Mars Mission Definition: Requirements & Issues Panel
Mission Architecture and Transportation Panel
Phobos Next: Human Exploration of Mars from Martian Orbit - International Space University
Sam Scimemi Presentation (NASA Director, International Space Station)

May 7, 2013

Propulsion Options Panel
Entry, Descent, and Landing Panel
Living on Mars: Biomedical Challenges Panel
Living on Mars: Habitation and Life Support Panel
Mars Agriculture and Food Production Panel

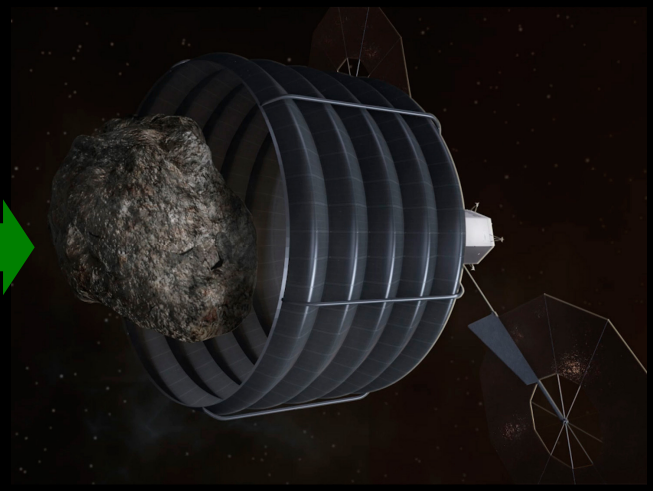
May 8, 2013

Planning for the Long Haul: Mars Program Directors Panel
International Cooperation Panel
Inspiration Mars Panel
Policy Challenges Panel
Buzz Aldrin Presentation (NASA Astronaut, Apollo XI, Gemini XII)
Public Engagement Panel

Precursor Missions Panel

- ATK selected as supplier for the Asteroid Exploration Mission
  - This will be a solar electric power (SEP) demo, mid 2020s

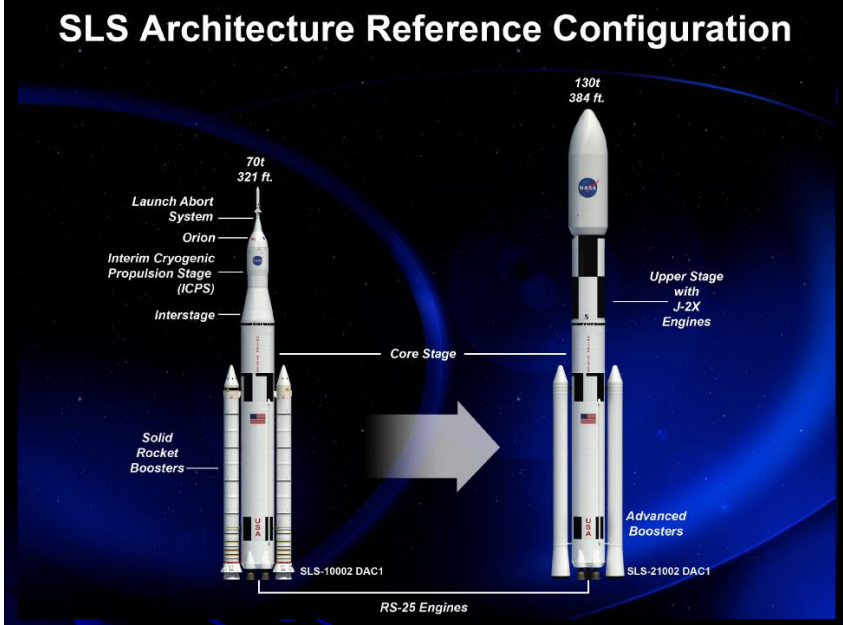
- Debate raged in the lecture hall: why unmanned vs. the original plan for a manned visit?
  - Q1: Why an asteroid?
  - A1: Enables later missions without the EDL issues
  - Q2: What about life support?
  - A2: ECLSS proven on ISS
  - Q3: How is SEP power relevant to H2M?
  - A3: Tech demo for cargo missions

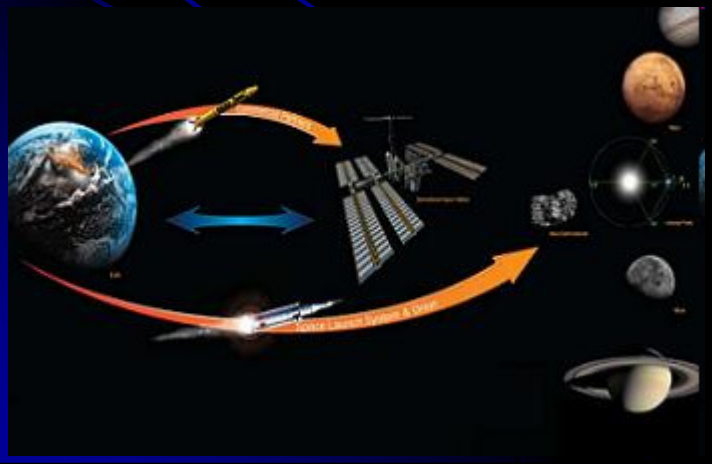


Science and Engineering Panel

- "Self reliance is a key new requirement" – Houston control far away
- Near-Term R&D Efforts: Next Gen Life Support (NGLS), In Situ Resource Utilization Testing (on Earth?), 'EVA Glove' space suits
- Long-Term R&D Efforts: Cryo Propellant Storage and Transfer (CPST), composite cryo tanks, Solar Electric Propulsion (SEP)
- Q1: Top Challenges? A1: advanced radiation protection & access to surface (Entry-Descent-Landing, or EDL)
- Q2: Deep space hab test plans? A2: No firm plans or schedule (!!) per Dr Bret Drake, whose title is 'Human Mars Architect Lead'
- Q3: ISS role in testing? A3: Reliable closed loop ECLSS in space
- Q4: ISRU material plans? A4: Initially CO2 to extract O2 for crew, H2O ice for O2 and H2 return fuel, and raw surface soil
- Q5: Is exploration for Low Mars Orbit on the table? A5: Does avoid EDL but there are zero G issues, fewer resources, and psych issues

Mission Architecture and Transportation Panels

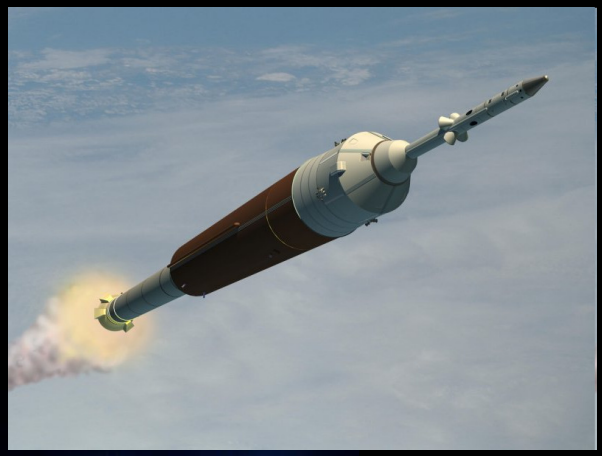




- 2009 Design Reference Architecture 5 (DRA5) is still the official baseline
  - IMLEO needs 8 SLS launches!
  - Does not leverage ISRU
  - Unsustainable "All Up" architecture
  - Desperately needs to be revised
- Sustainable solution (DRA6?):
  - Leverages ISRU
  - Scales to fit budget
  - Modular to allow pre-deployment
  - Reusable components
- SLS: IOC 70t, 321ft stack, 2017 – 2021
  - FOC 130t, 384 ft stack, 2021- 2048
- Incremental options: 2021 EM L2, 2026 asteroid, 2030 Deimos visit, 2033 surface

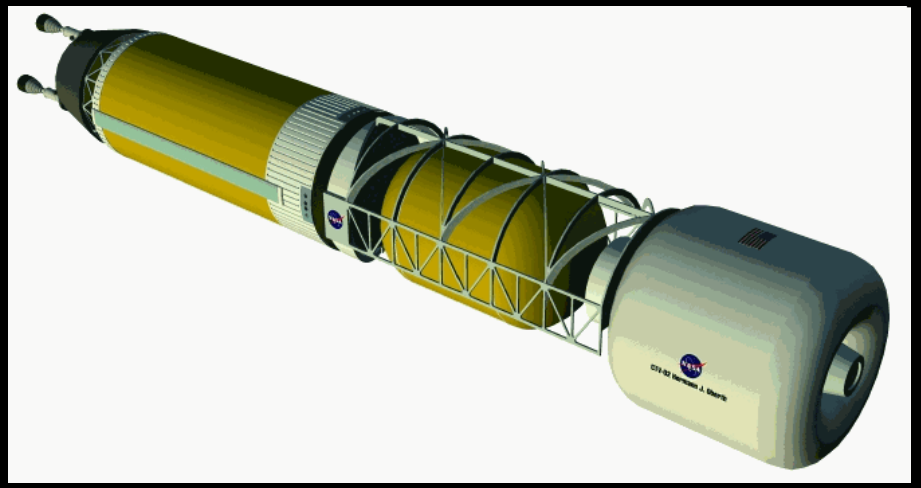
Propulsion Options Panel

- NASA is relaxing it's "all up" resource launch strategy by allowing some In Situ Resource Utilization (ISRU) of breathable Oxygen from the CO2 atmosphere. A 40 Metric Ton (t) on Mars value for a crew of 6 still presupposes that the rocket fuel is delivered to the Mars surface. This could be divided by 2 if ISRU of fuel is allowed.
- Possible modification to DRA5 design reference architecture propulsion would allow for Solar Electric Power (SEP) zero erosion Hall effect thrusters for cargo precursor missions to land habitat and return vehicle (slow transit time), and a cryogenic fuel rocket propulsion (SLS + Orion) for the crew for faster transit times.
- Ascent and return craft could be fueled by ISRU, Mg from Mars regolith and CO2 from Mars atmosphere. Mg could be burned in a dual mode ascent and return with Mg as the ion source for a Hall effect thruster, and Mg + CO2 as rocket fuel. CO2 could also be captured via ramair intake on ascent for a scramjet design off the surface.



Biomedical Panel

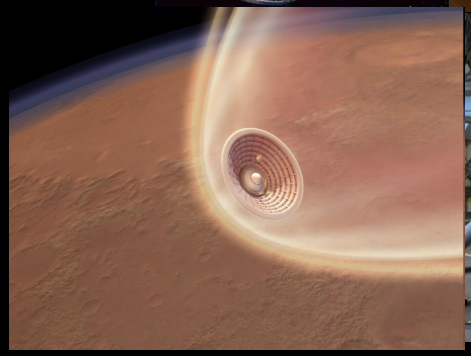
- Main health effect risk mitigation steps: radiation, micro gravity, and isolation / confinement.
- Visual impairment due to inter-cranial pressure & optic nerve sheath swelling – TBR
- Little problem of 50% success rate to surface landing
- Personalized medicine is now a real possibility based on an astronauts genes: "Pharmo-Astro-Genomics"
- Mars 500/520 confinement study showed some people deal with confinement better than others - appears in first 30 days and continues linear degradation during entire mission.

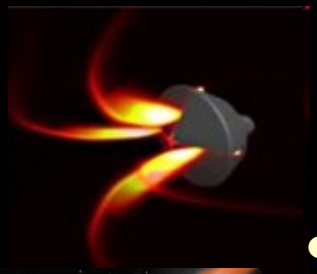
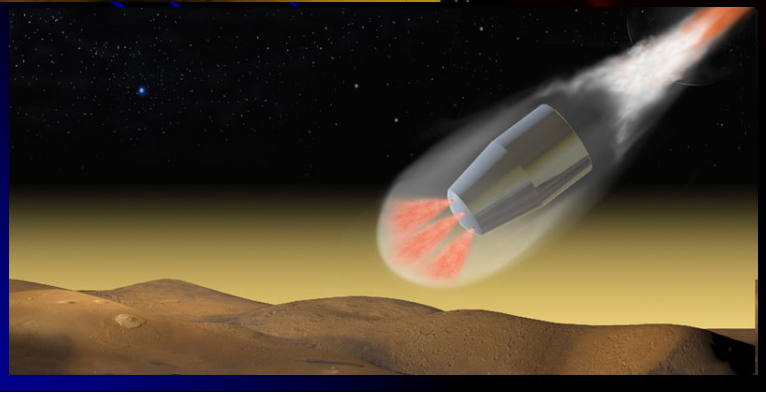


Entry Descent and Landing Panel

- EDL is major hurdle: airbag landings and parachutes with skycranes will not scale to human surface habitation and equipment needs (5t – 40t on surface)
- New approach will require aeroshell "transforming" into HIAD, then retro-rocket deceleration





- HIAD = Hypersonic Inflatable Aerodynamic Decelerator, this first stage in slowing down at high altitude
- Final stage will require supersonic to transonic retrorockets, now the subject of intense R&D efforts

Living on Mars: Life Support Panel

Mars One presented its human settlement plan in very broad strokes - not much detail yet:

- 2016 tech demo for cargo
- 2018 water seeking rover
- 2020 unmanned habs landed
- 2023 first human landing
- Then habs and humans land in alternating waves

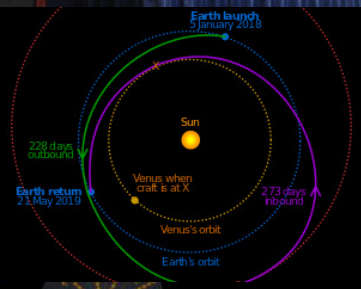
- Paragon presented that the three biggest problems will be:
  - 1) Dust
  - 2) Water
  - 3) Breathable Oxygen
- Boeing presented how ISS ECLS systems could be reused for Mars missions
  - Recommended "equivalent mass" as a good figure of merit for judging mass + power requirements (convert power needs to power system mass)
  - Recommended escape to orbit as a possible form of contingency ops if surface ops go horribly wrong.

Mars Agra Panel

- Plants do not need 1 Atm to do well - 1/3 atm or even 10% atm might be OK - they adapt to changes in pressure by switching on different genes. BTW 50% of plant genes are shared with humans - TBD what this means, but Mercury and Gemini often operated at 1/3 atm.
- Plants can be incorporated into overall life support via waste processing and O2 generation and should be judged on overall ECLSS system equivalent mass.
- 3D printed food is an option but current technology (rehydrated powder combinations) did not sound that appetizing. The technology has a long way to go but is very promising.
- Diverse seed bank is recommended, in conjunction with leveraging "genetic competence" of Earth plant species for Mars environments (e.g. genetic engineering, or franken-food)

Lettuce growing in a low-pressure dome at the Kennedy Space Center

Inspiration Mars Panel



- Humans to Mars by 2018 will keep public excitement going long enough to support a 2033 landing
- Trans Mars Injection burn needs to happen on exactly 1/5/18
  - LEO staging will need to happen earlier - Xmas 2017?
- Arrival at Mars 8/20/18 with 7 km/s flyby speeds
  - Similar to ISS orbital speed
- Returns to Earth 5/2/19 - 501 days total (1.4 years)
  - Similar to long duration isolation tests (Mars 500)
- 14.2 km/sec Earth return (Apollo reentry was 11 km/sec)
  - May be able to add density to existing designs to cope
- Launch options include Falcon Heavy, two Atlas (one for empty vehicle and one for fuel) with on orbit refueling, or SLS / Orion / Transhab
- Orbit is a Hohmann transfer with excursions between Venus and Martian orbits
  - Solar radiation will vary from 188% Earth to 52% Earth
- ECLSS is ISS derived = 4000Kg, Consumables + Food + Water = 6000Kg
  - ECLSS gnd test facility in development 2013; in chamber 2014

Policy Panel:
“How Not to get to Mars”

A 40 year history of failed policy resets:

1969 - Congress cancels NASA's RFP for Mars Flyby (basically Inspiration Mars 40 years ago)

9/15/69 - A Mars landing in 1986 was recommended; got space shuttle instead

1986 - National Commission on Space recommended Mars Mission - then the Challenger accident happened

1987 Ride report recommended a "Sprint to Mars" to overcome political obstacles

7/20/89 - Space Exploration Panel recommended Moon then Mars as NASA goals

1991 - Synthesis Group Report proposed Mars by 2016

2004 - Vision for Space Exploration set Moon 2020 as a goal, then Mars

2009 - Augustine Report - Mars above all

2010 - National Space Policy - orbit Mars by 2035

2012 - NASA Budget 17.7B for 2013 - 2018; "Flat is the new up.“

2013 - Human Space Flight (HSF) policies, programs, and budgets are not aligned. "Need to steer, not drift."

Neil deGrasse Tyson: "Apollo in 1969. Shuttle in 1981. Nothing in 2011. Our space program would look awesome to anyone living backwards thru time.”

Summary of 2013 H2M Summit

- Positive Takeaways:
  - There was a prevailing attitude that if NASA does not take a leadership role in the human exploration of Mars they will be overcome by events, i.e. "made redundant"
  - There was an acknowledgement that the public mood has shifted from one of ambivalence to very pro-human-exploration, supported by the latest Explore Mars surveys
  - NASA continues to be a reservoir of talent that can help make Humans to Mars happen
- Remaining Challenges & Next Steps:
  - Supersonic / transonic retrorocket restart needs a design
  - ISRU (In Situ Resource Utilization) needs to be tested on the Martian surface if it is to be depending on for providing return fuel
  - Biomedical related challenges, e.g. radiation protection and artificial gravity, must be put to rest and a baseline approach must be established to support a real design reference architecture; (**DRA5 needs updating**)

H2M 2013 was the first but will not be the last: an H2M 2014 is now planned