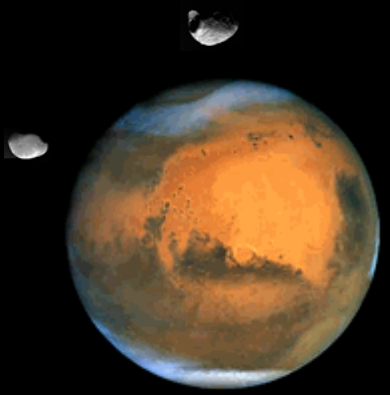
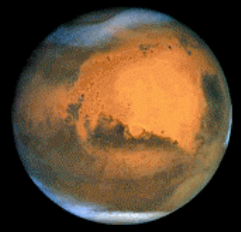
Wherefores And Whyfores in the Next 50 Years



L2

Noel W. Hinners
October 28, 2008
NASA Masters Forum

Predicting Civil Space Futures The Next 50 Years



- Forecasts for the first 50 years of space exploration
  - Many didn't happen, e.g.:
    - Extended lunar exploration (e.g., 6-6-12, Molab)
    - Human exploration of Mars
    - Fully reusable and inexpensive space transportation
  - Many not forecast did happen, e.g. revolutions in:
    - Micro-chips & processors
    - Robotics
    - Life sciences

"The future ain't what it used to be" (Yogi Berra)
It will be better, different & largely unknowable
Adaptability & evolution are key requisites

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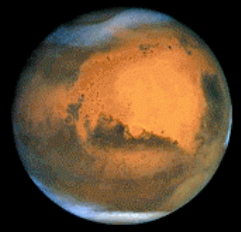
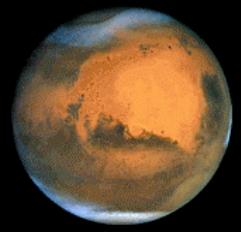
Space & Earth Sciences & Aeronautics



- Earth science
  - NASA is the leader in space earth science research
    - "Applications" role diffuse (NOAA, DOD, NASA)
  - In and out of the political doldrums for decades
  - Reinvigoration at hand: global climate change recognized
  - The science needs are evident
- Space sciences
  - Continuous advances & public support
  - So much to do, such limited opportunities (nature of the beast)
  - Maintain balance of large & small (whales eat plankton)
  - Maintain the R&D programs in concert with Academia
  - Take proper advantage of and contribute to human exploration
- Aeronautics

Grand challenges:1. Funding allocation between space & earth sciences 2. Role of humans in space

The Grand Challenge: Whence the VSE Goal of the Human Exploration of Mars?



REALITY #1: We are in no position today to commit to the human exploration of Mars; irrational exuberance doesn't hack it.

REALITY #2: We do not have an overall exploration strategy, technology plan or budget that gets us on the path to, much less to, Mars in the foreseeable future (e.g., by ~2030's).

IF: Human exploration of Mars is to be a viable goal achievable on a reasonable time scale,

THEN: Pre-Mars human space activity must be designed with that end as a primary driver with a focus on risk reduction and visible step-by-step progress.

Budgets aside, the human exploration of Mars will remain virtual until the total risk situation is identified, quantified, parsed and systematically mitigated with relevant programs.

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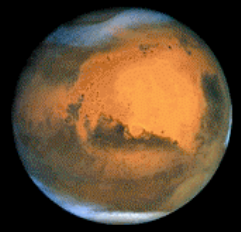
Meeting the Humans to Mars Challenges – "Level 0" Requisites



Political

- Comprehensive. multi-decade HEx strategy
- Clear, timely, focused evolutionary goals
- Public (and Congressional) support

} Budgets

Technical/Programmatic

- Heavy lift launch capability (Ares V class)
- A comprehensive understanding of Mars
- Extremely reliable and safe crews and mission systems
- A focus on Mars-related capability development and risk mitigation.
- An effective human – robotic partnership

These are necessary but insufficient: we must also learn from past human space flight programs

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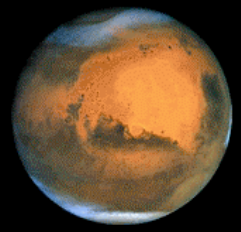
Lessons (to be or not to be) Learned



- Shuttle and ISS have a message for us
  - Remarkable engineering accomplishments
  - Initially all-encompassing goals
    - Maximized buy-in and support
    - Some goals patently unachievable (e.g., launch rate, economics, suitability for science)
    - Utilization suffered, and suffers, from build, develop and get on to the next development mentality
  - Inadequate budgets when needed
    - Horrendously inefficient development profile for ISS
  - No *ab initio* exit strategy to enable next desired step(s)

What would Santayana say?

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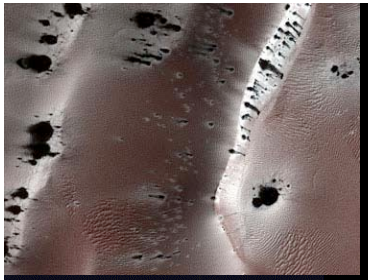

Public Support, the Intrigue of Mars and the MEP

- There is great public interest and knowledge about Mars:
- Q: Why? A: It's
  - **Inspirational:** "Wow! We're doing that?" Rovers, images: a never-ending stream of new discoveries
  - **Relational:** "familiar" features corresponding to those on Earth while simultaneously presenting mysteries: ancient water, sediments, dust devils, dunes, canyons, volcanoes, polar caps, hydrothermal minerals, etc.
  - **Intellectual:** possible extant or prior life (astrobiology)

The MEP, arguably NASA's most impressive and productive planetary program, requires resuscitation. It must be kept timely, vigorous and relevant. The MEP is today's way to keep a VSE Mars connection.

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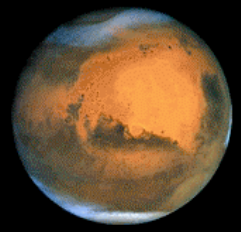
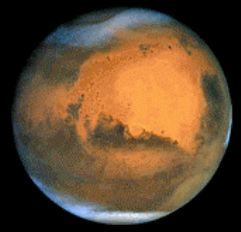
Required: Extremely Reliable and Safe Crews and Mission Systems (1)



- Crews that can function safely and efficiently over a three year period are the *sine qua non* of human exploration of Mars
  - Major human risk issues are well known (bone, muscle, blood, immunity, psychology, +)
  - Best resolved using the ISS with the probable exception of the psychological. Boredom, isolation and personal interactions might be the major challenge
- Complex mission systems ("self-sufficient" for periods of 3 to 7 or more years) must be developed and "certified."
  - Challenges: redundancy, fault tolerance, safety, repair, etc.
- Robotic precursors to acquire essential data for health, safety and mission optimization

Required: Extremely Reliable and Safe Crews and Mission Systems (2)

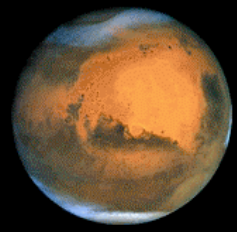


A time-phased approach to capability development

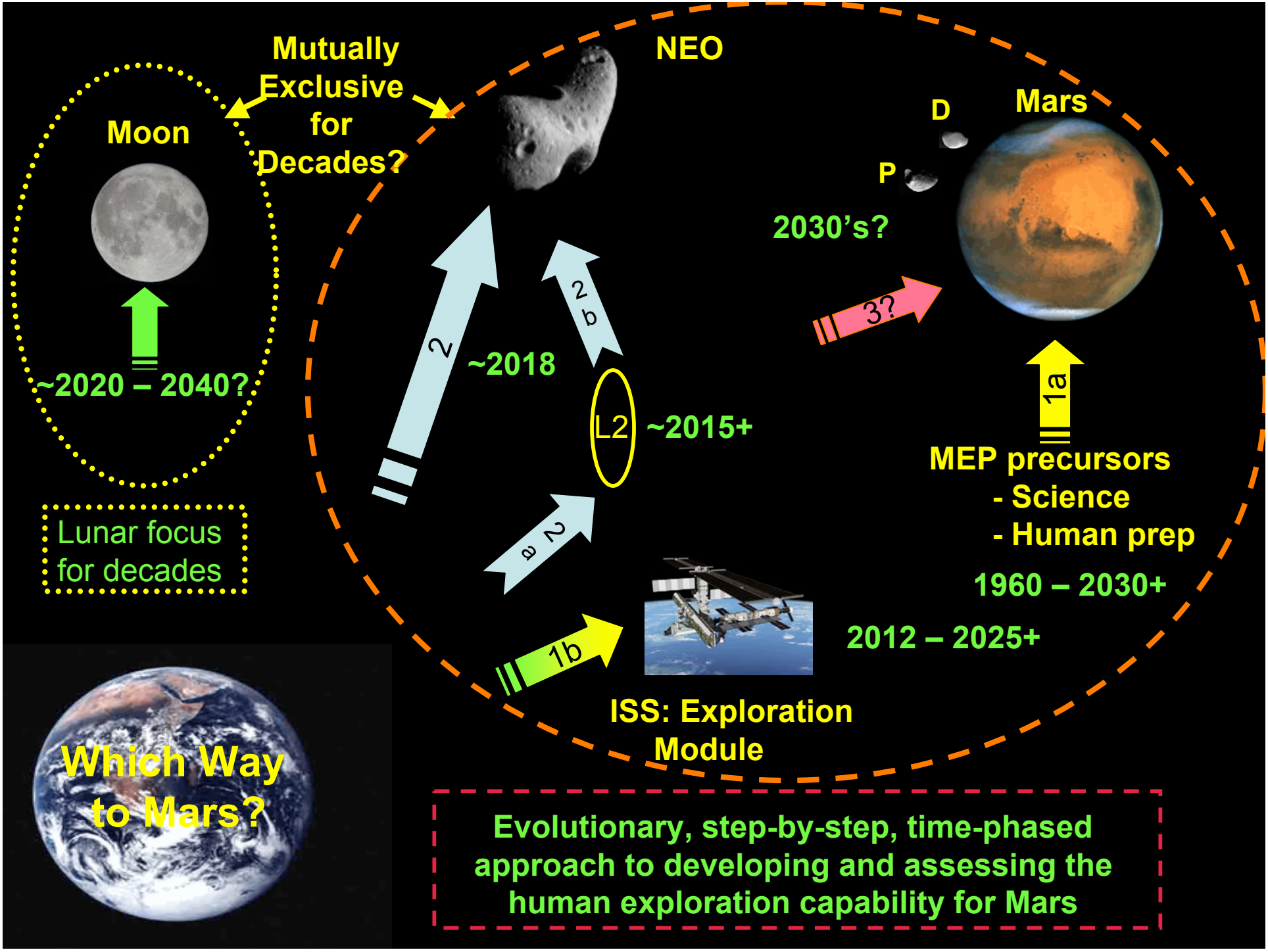
1. Partial to full duration L2, NEO and Mars simulations in prototype or actual crew systems should be done on earth and then on the ISS.
2. Increasingly stressing (long duration) missions such as L2 and NEO can test the goodness of proposed solutions for transits.
3. Mars Entry, Descent, Landing and Ascent systems development (we do not have a technical solution to EDL today for HEx of Mars)
4. Mars habitats and surface mobility systems benefit from lunar developments
5. Mass reduction approaches require assessment & development (Mass = Cost), e.g., mostly-closed life support systems, efficient propulsion, ISRU **(?)**

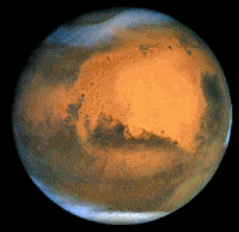
Steady, incremental development of a Mars capability through a program with interim productive mission accomplishments.

The Human - Robotic Partnership



- Robotics are essential to the HEx of Mars
  - Science missions as preparation for WHAT humans will do on Mars: science (see HEM-SAG) and survival
  - Acquisition of essential health and safety information from in-situ experiments and Mars Sample Returns (MEPAG Goal IV and ND-SAG)
  - Mars Sample Returns will be a 'proof-of-concept' for the Mars Round Trip and a model for international Mars exploration.
  - Demonstration of potential enabling technologies, e.g., EDL, ISRU (?) and pre-HEx deployments
  - Assisting humans at Mars to do that for which humans are not essential
  - Use humans for tasks that are difficult or costly to automate, e.g., complex mechanical deployments. After all, humans will be there.


Mutually Exclusive for Decades?
Moon
~2020 – 2040?
Lunar focus for decades
NEO
Mars
D
P
2030's?
3?
2
~2018
2a
L2
~2015+
2a
1a
MEP precursors
- Science
- Human prep
1960 – 2030+
1b
2012 – 2025+
ISS: Exploration Module
Which Way to Mars?
Evolutionary, step-by-step, time-phased approach to developing and assessing the human exploration capability for Mars



The human exploration of Mars is a daunting and risky, yet worthy and not impossible, challenge. However, one cannot simply decide one day to "do it." By any and all measures it is vastly tougher than Apollo. It requires a dedicated focus, steady incremental and evolutionary preparation and stepwise risk and reality evaluation spanning decades. The public must be fully informed and supportive.

As our good friend Santayana would say,
"Sanity is a madness put to good use"

Noel W. Hinners

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Not If,
But When
&
By Whom