Low-Latency Telerobotics From Mars Orbit: The Case for Synergy Between Science and Human Exploration

Based on Findings from:
"The First Symposium on Space Exploration via Telepresence: A New Paradigm for Human-Robotic Cooperation"

Symposium Briefing on May 2-3, 2012
NASA Goddard Space Flight Center

A. Valinia[1], J. Garvin[1], R. Vondrak[1], H. Thronson[1], D. Lester[2], G. Schmidt[3], T. Fong[4], B. Wilcox[5], et al.

1 NASA Goddard Space Flight Center
2 University of Texas at Austin
3 NASA Glenn Research Center
4 NASA Ames Research Center
5 NASA Jet Propulsion Laboratory

http://telerobotics.gsfc.nasa.gov/

The First Exploration Telerobotics Symposium

http://telerobotics.gsfc.nasa.gov/

Participants were a diverse group of key stakeholders to understand the **challenges** and **future opportunities using telepresence** as a productive strategy for human space and scientific exploration.

~100 participants among

- planetary scientists
- space robotic engineers
- human space flight experts
- terrestrial robotics users
- academia
- NASA (incl HQ), and CSA, ESA, JAXA
- industry
- policy/press

Findings and observations currently being compiled in a report and will be submitted to NASA HQ, and posted on symposium web site.

The Conference Framework

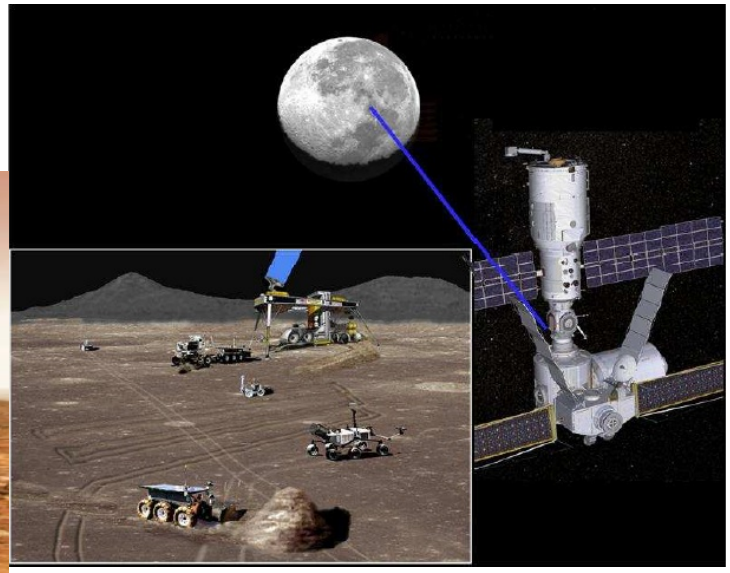
Explore inaccessible and hazardous regions of other planetary bodies via "*proximity*" robotic operations from planetary orbit.

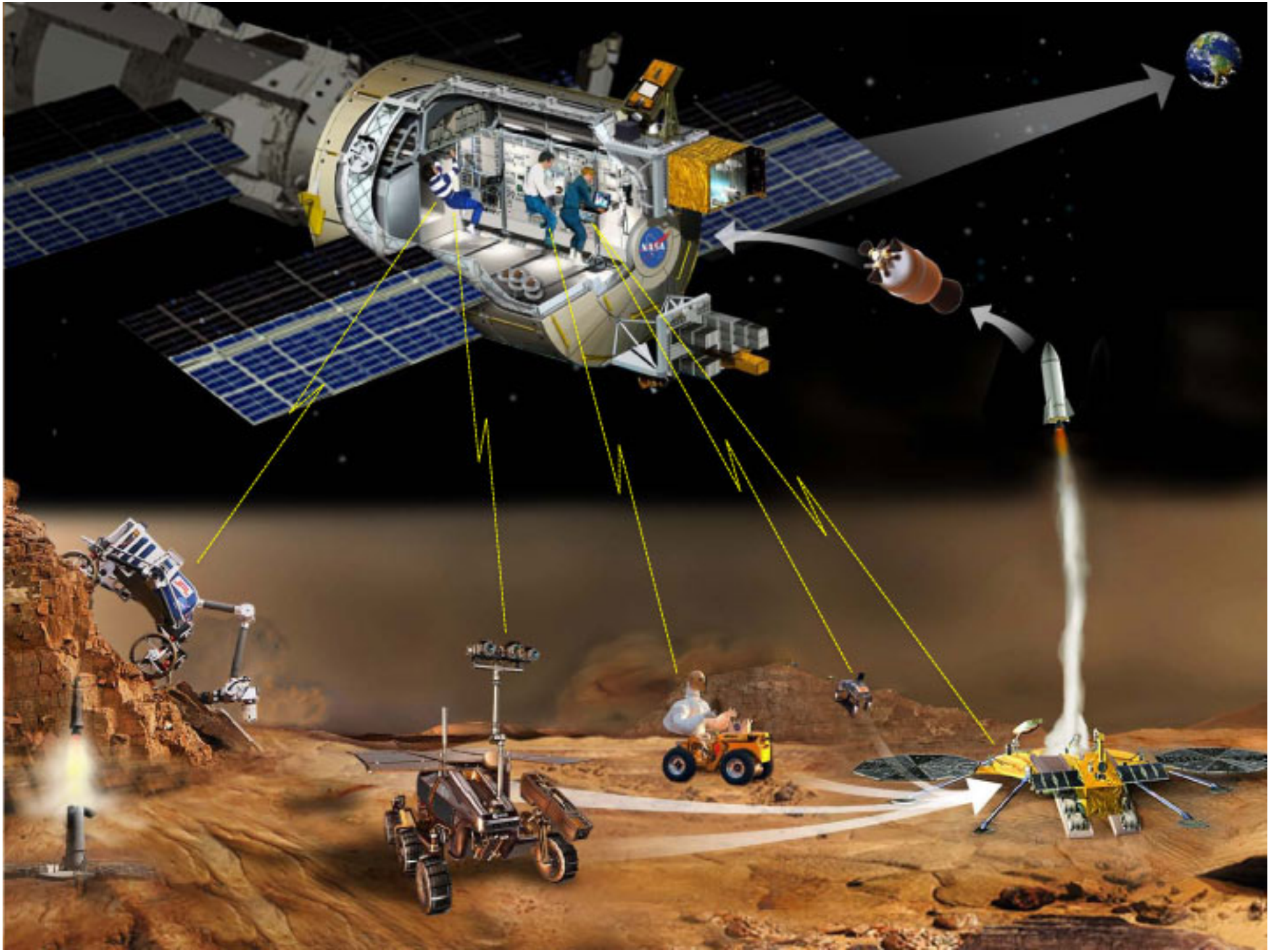
- Humans remain in locations where control of robots on planetary surfaces is limited by round-trip light-travel time **< 500 ms (low latency)**
- Extend human cognition to the surface of Moon, Mars, and other bodies without the challenges, expense and risk of putting humans on hazardous surfaces or within gravity wells
- Achieve synergy between human and scientific exploration of other planetary bodies by surface **telepresence** of "astronaut" scientists

Cognitive Horizon

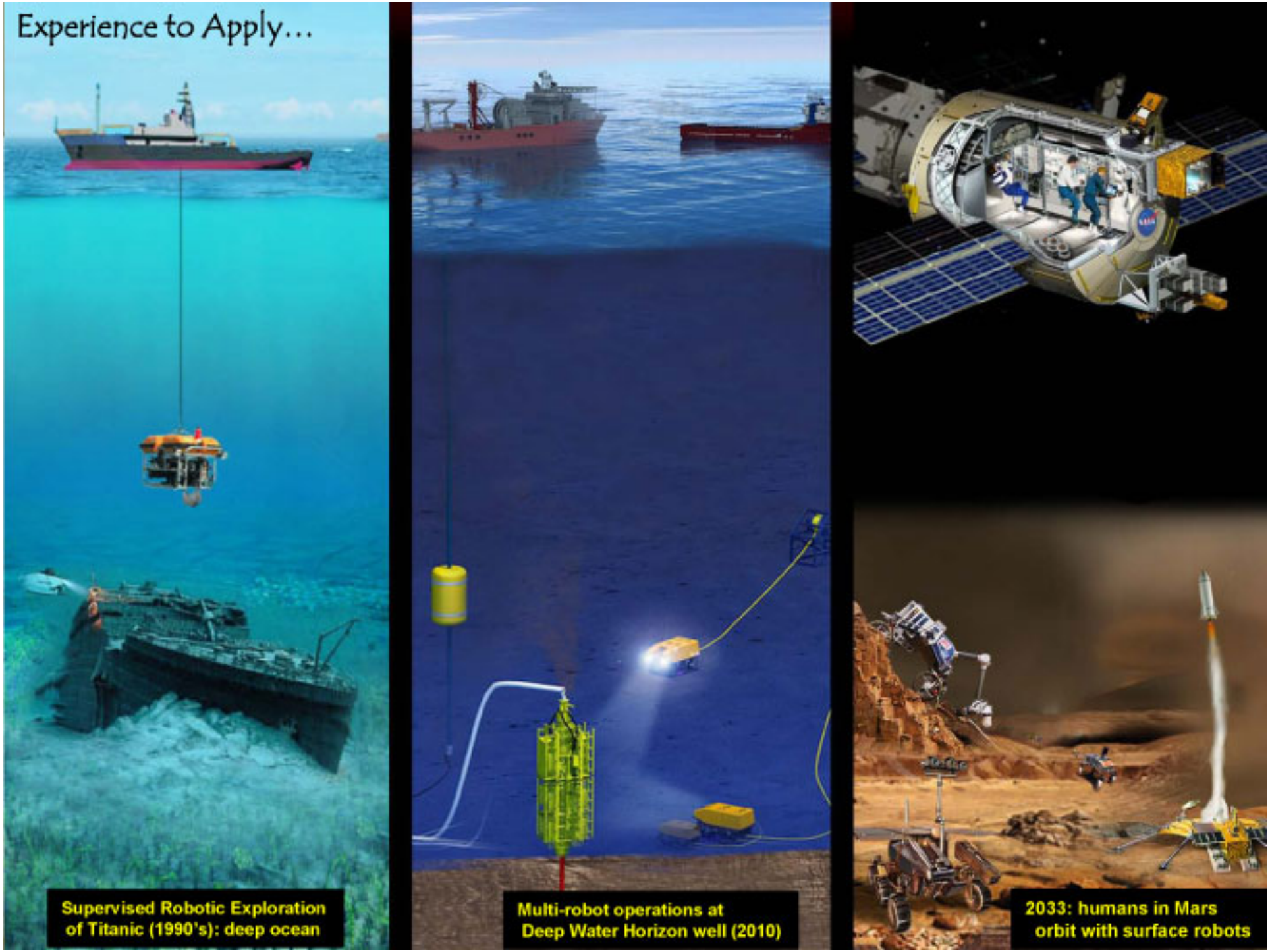
- Putting human cognition (relevant human senses and dexterity) at a remote site requires:
  - Low communication latency: < 200-500 ms (~30,000km: cognitive horizon)
  - High bandwith (human eye performs at 10Mb/s)
- For the Moon, humans work at EM L1/2 or LLO
- For Mars, humans work at

  Mars orbit, Phobos, Deimos

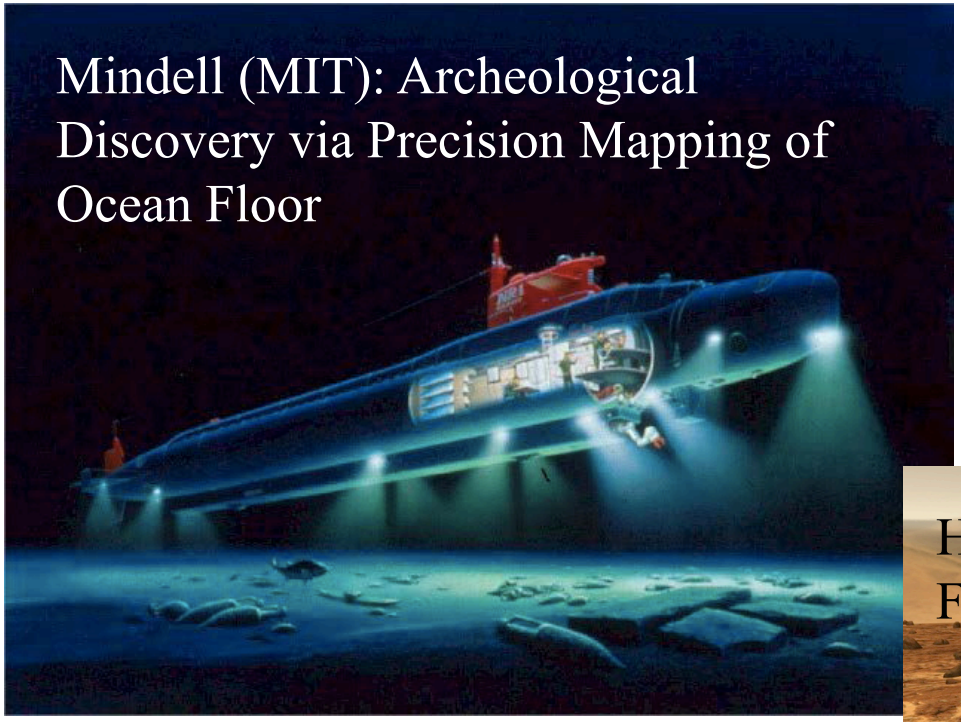




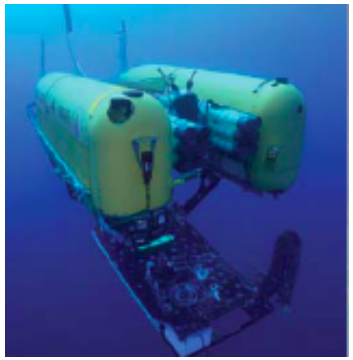
Experience to Apply…

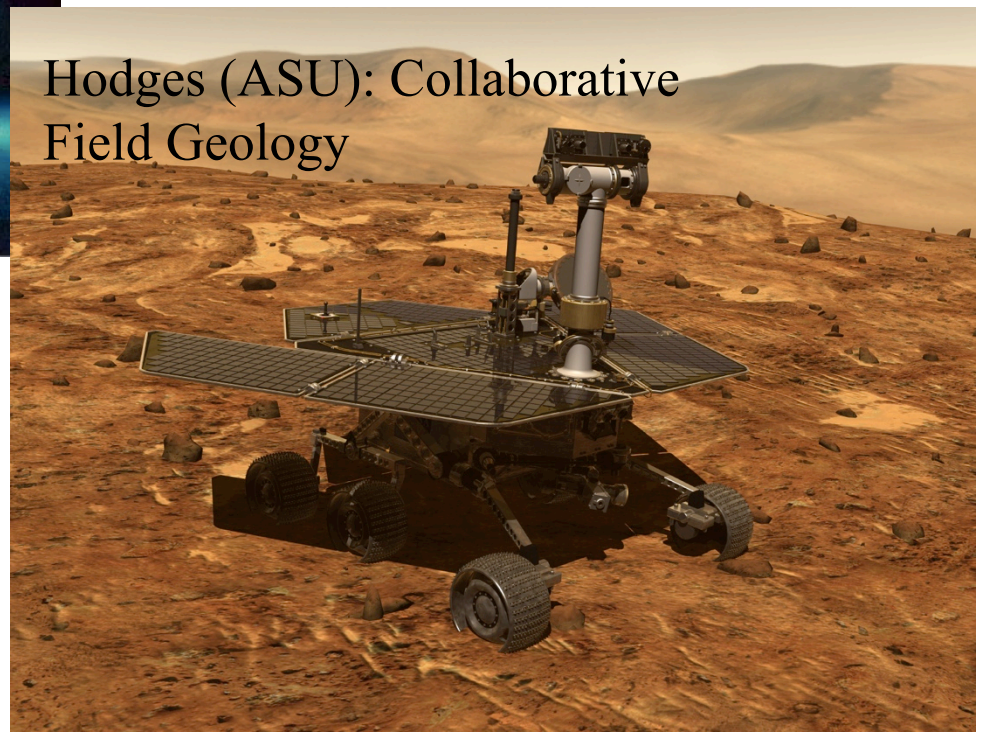


Highlights of Symposium: Day 1



Whitcomb (JHU): 50 years of Deep Ocean Telerobotics Exploration



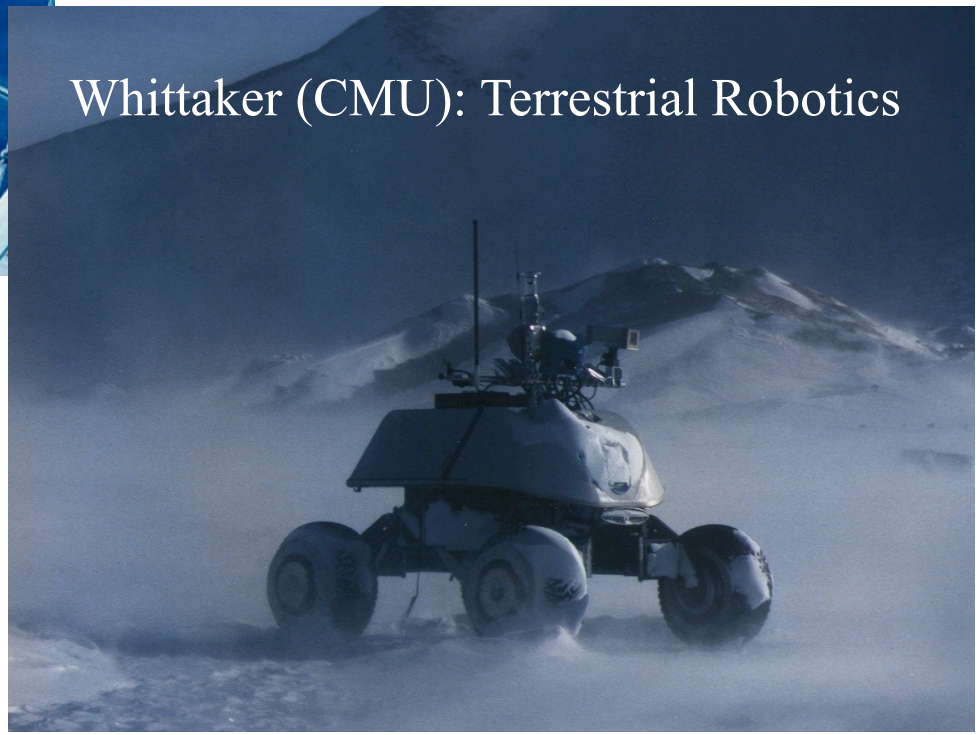


Vertesi (Princeton): Telerobotics Sociology

Highlights of Symposium: Day 1

Kazanzides (JHU): Telerobtics in Medicine

Schiele (ESA): METERON



Highlights of Symposium: Day 2

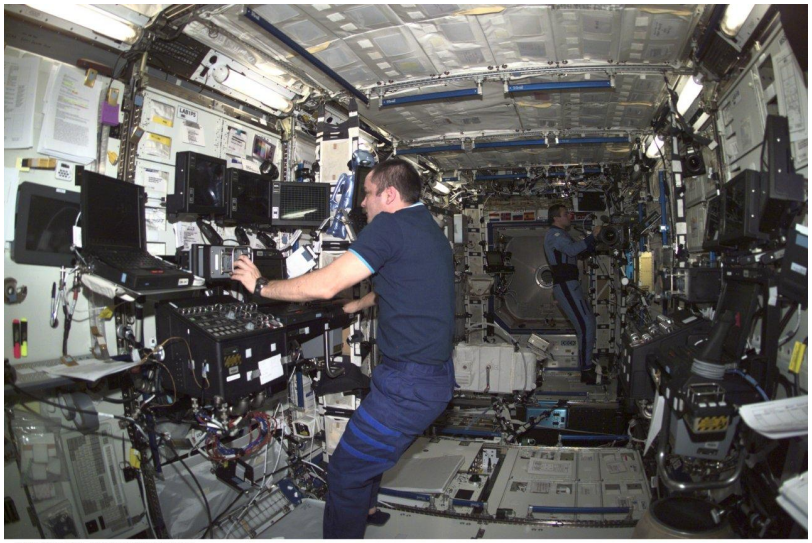
Preliminary SCIENCE Findings

- Discussions on science scenarios for Moon, **Mars**, SBs, and Venus and relevance to the priorities of the decadal survey
- Low-latency human-robot collaborative work in surface geological exploration of Mars
- On-orbit telerobotic sample recovery and return to the crewed orbiting facility for immediate analysis by resident astronauts (e.g. may enable rapid analysis of volatile bearing samples without requiring long-term cryogenic storage)
- Areas that precludes human access can particularly be explored via telepresence
- Keeping humans away from sites where extant life may exist could be a compelling rationale

Highlights of Symposium: Day 2

Preliminary HUMAN SPACE FLIGHT Findings

- Proven value of terrestrial telepresence technologies in industry, commercial, and research endeavors **– improving safety, saving lives, saving costs, improving operational efficiency, and enhancing science return.**



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- Synergistic science and human exploration activities via low-latency telerobotics:
  - **Science operations on Mars** controlled from orbit or Lagrange point, or on the surface
  - **Assembly operations of large structures** from orbit or Lagrange point

Highlights of Symposium: Day 2

Preliminary TECHNOLOGY Findings

- A few areas that need development and testing with proximity in mind (*cf,* NASA OCT Robotics, Telerobotics & Autonomy Roadmap (TA04)):
  - **Sensing and Perception**
  - **Mobility**
  - **Manipulation**
  - **Human-System Integration**
  - **Autonomy**
- Sample return technologies e.g. canister rendezvous, acquisition and return to the orbiting station needs to be demonstrated.
- High-fidelity analog missions with **authentic science** to test a range of **operational concepts** and **telerobot control modes**

Next Steps

- Engage the scientific community in topical workshops to **develop specific low-latency telepresence scenarios** for scientific exploration of Mars tied to the NRC Decadal survey goals.
- **Operations feasibility assessment** needed at analog field sites (some already in development e.g. from ISS and were presented at GLEX 2012).
- **Investments in key robotics technologies** such as sensing, perception, mobility, manipulation, human systems integration and autonomy are needed.
- **Foster international collaboration** and public/private partnership.